LOGY DEPARTMENT

May 1947

TECHNOLOGY REVIEW

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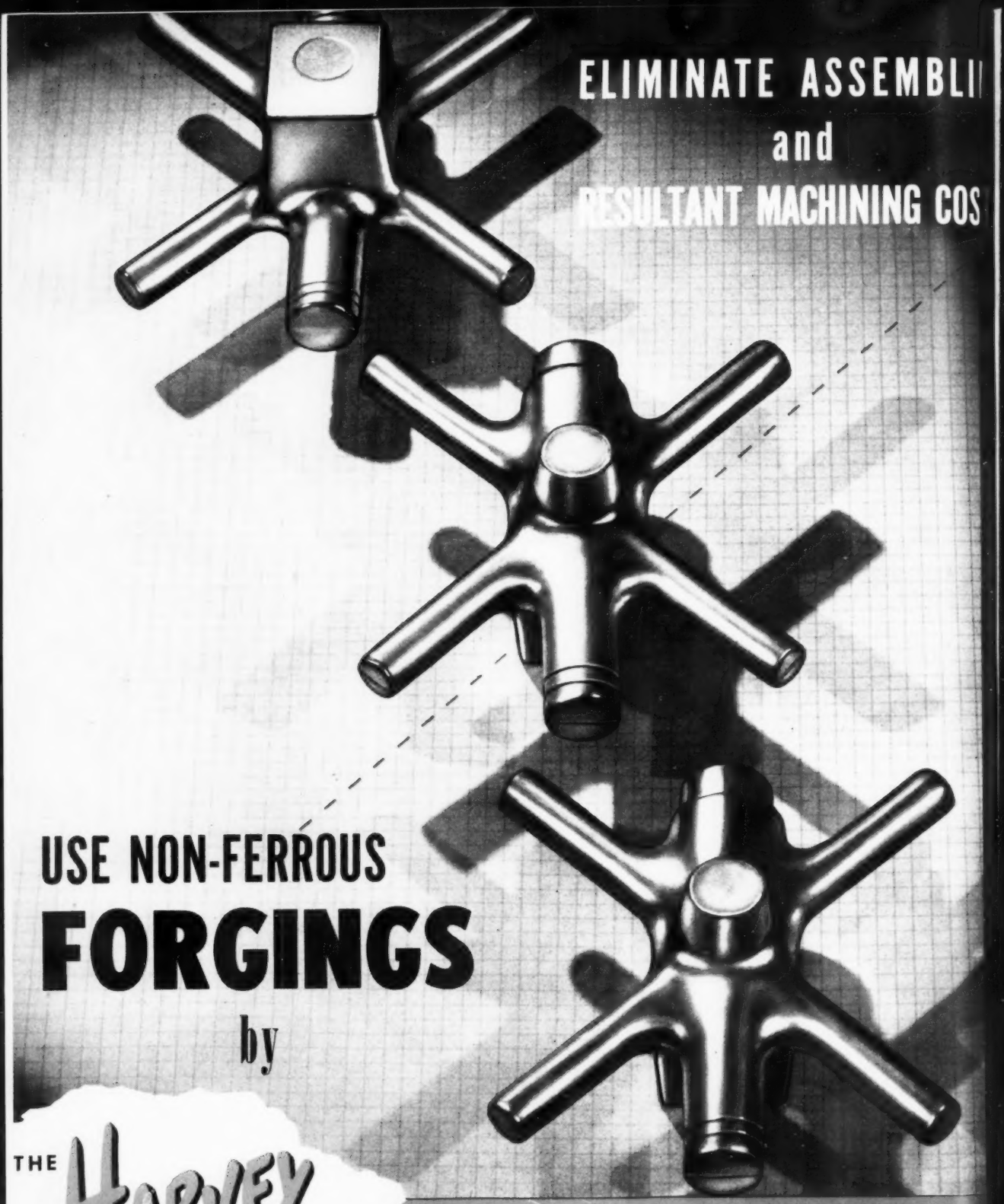

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and
RESULTANT MACHINING COS

USE NON-FERROUS
FORGINGS
by

THE HARVEY METAL CORPORATION

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FORGINGS IN ALUMINUM • BRASS • BRONZE • COPPER • MAGNESIUM • MONEL • ALLOY

MACHINING FACILITIES

Of
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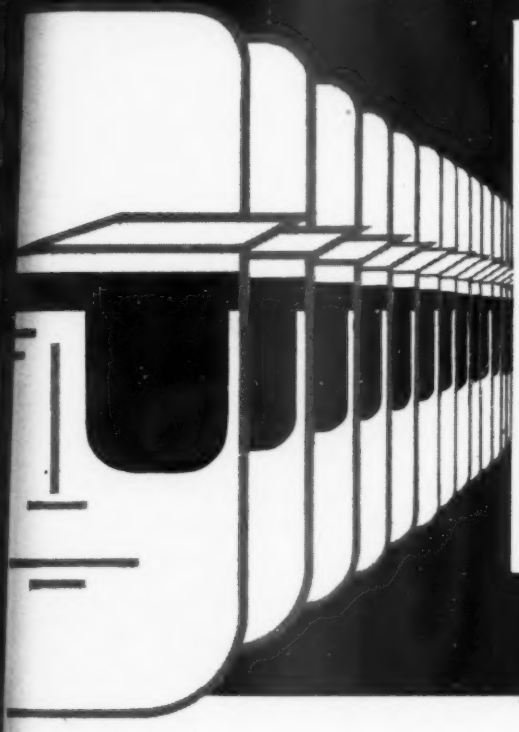
*17 Industrial Workers Will Lose the Sight of One or Both Eyes TODAY



AN ALARMING COST TO INDUSTRY

Yet Almost Wholly PREVENTABLE

*U. S. DEPT. OF LABOR-ESTIMATE

Of the 17 serious eye accidents in industry that will happen in the next 24 hours, 16 could be prevented *now* by use of safety goggles. Eye accidents are estimated to cost industry $5 per shop worker per year—an alarmingly high figure. Yet, according to the Society for the Prevention of Blindness, 98% of eye accidents can be prevented by the use of safety goggles —at an average cost of only $1.50 a pair.

Are *you* overlooking this opportunity to effect a substantial cost reduction? If so, we suggest you get in touch with your nearest AO Safety Representative for advice and help in establishing an adequate eye-protection program in your plant.

American Optical COMPANY *Safety Division*

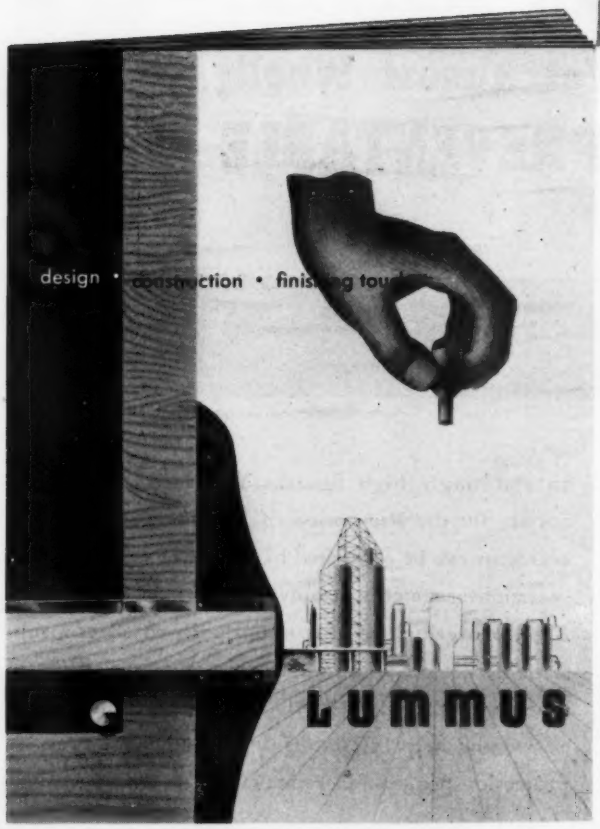
SOUTHBRIDGE, MASSACHUSETTS • BRANCHES IN PRINCIPAL CITIES

THE TECHNOLOGY REVIEW, May, 1947. Newsstand Edition. Vol. XLIX, No. 7. Published monthly from November to July inclusive at 10 Ferry Street, Concord, N. H. Publication date: twenty-seventh of the month preceding date of issue. Annual subscription $3.50; Canadian and Foreign subscription $4.00. Entered as second-class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879.

new Lummus *publication*

...on petroleum refining processes

contains 64 pages of timely, authoritative information for petroleum refiners and chemical manufacturers



With text, data, photographs, and 22 flow diagrams, this tenth refinery publication of The Lummus Company describes the latest processes and plants for the manufacture of gasoline—lube oils and waxes—petroleum chemicals. It defines Lummus services, facilities, and world-wide experience in design, construction, and supervision of petroleum and chemical plants.

THE LUMMUS COMPANY
420 Lexington Avenue, New York 17, N. Y.

LUMMUS

PETROLEUM PROCESSES AND PLANTS

CHICAGO—600 South Michigan Avenue, Chicago 5, Ill.
HOUSTON—Mellie Esperson Bldg., Houston 2, Texas
LONDON—78 Mount Street, London, W. 1, England

Copies of **"Petroleum Refining Processes"** will be sent upon request

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OPEN STRUCTURE
Grinding Wheels?
Their Fast, Cool Grinding Action Can Cut Costs on Many Jobs . . .
IF you have jobs where stock removal is heavy, where contact is broad or where extra coolness of cut is essential, it will pay you to try Norton OPEN STRUCTURE grinding wheels.
They are available in the several varieties of Alundum abrasive; also in Crystolon abrasive for grinding carbide tools. The combination of OPEN STRUCTURE and the new 32 ALUNDUM* abrasive is showing truly remarkable results in many plants.
Let a Norton abrasive engineer study your grinding jobs and specify OPEN STRUCTURE where it can save you time and money.
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Available in ALL NORTON ABRASIVES Including the Sensational New 32 ALUNDUM*
NORTON ABRASIVES

Arnold presents:

another step towards a complete line of permanent magnet materials . . . . .

CAST ALNICO I

CAST ALNICO II

CAST ALNICO III

CAST ALNICO IV

CAST ALNICO V

CAST ALNICO VI

CAST ALNICO XII

SINTERED ALNICO

SINTERED ALNICO

In general SINTERED ALNICO MAGNETS do not compete with, but rather supplement, magnets produced by the cast method to widen the scope of potential permanent magnet applications.

Alnico magnets weighing roughly one ounce or less should be produced by the sintered method.

Heavier magnets of more intricate shapes can be produced. For some applications Sintered magnets are more economical because:

1. Magnetic characteristics are practically the same as Cast Alnico.
2. Sintered Alnico is a fine-grain, homogeneous material which has more uniform flux density, is easier to grind, and provides better surface finish.
3. Sintered Alnico magnets can be produced to closer dimensional tolerances:

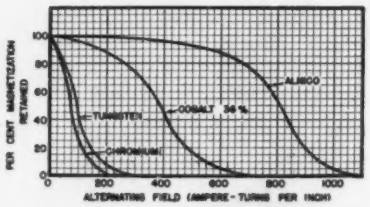
SINTERED ALNICO II	CAST ALNICO II
0.000 to 0.125 — + .005	0.000 to 2.00 — ± 1/64
0.126 to 0.625 — + .010	2.0 to 4.0 — ± 1/32
0.626 to 1.250 — + .015	4.0 to 6.0 — ± 3/64
1.251 to 3.000 — + .062	

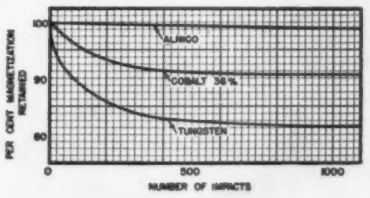
Grinding can in many applications be eliminated.

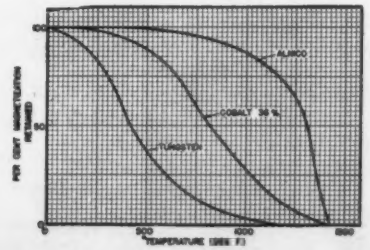
4. More intricate shapes, including holes, inserts, etc., are more feasible.
5. Transverse modulus of rupture is several times greater.

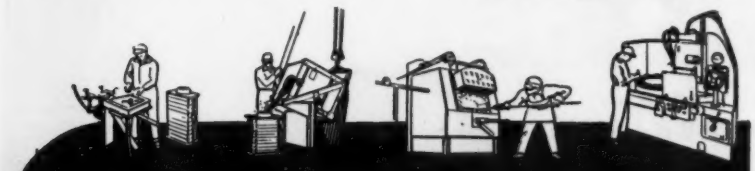
All Alnico, and particularly Sintered magnets, have very high values of Coercive Force (which is the capability of resisting demagnetization or loss of magnetism due to stray fields and from heat and vibration).

The curves show roughly the effect of these demagnetization factors on Alnico compared to other alloy steels.









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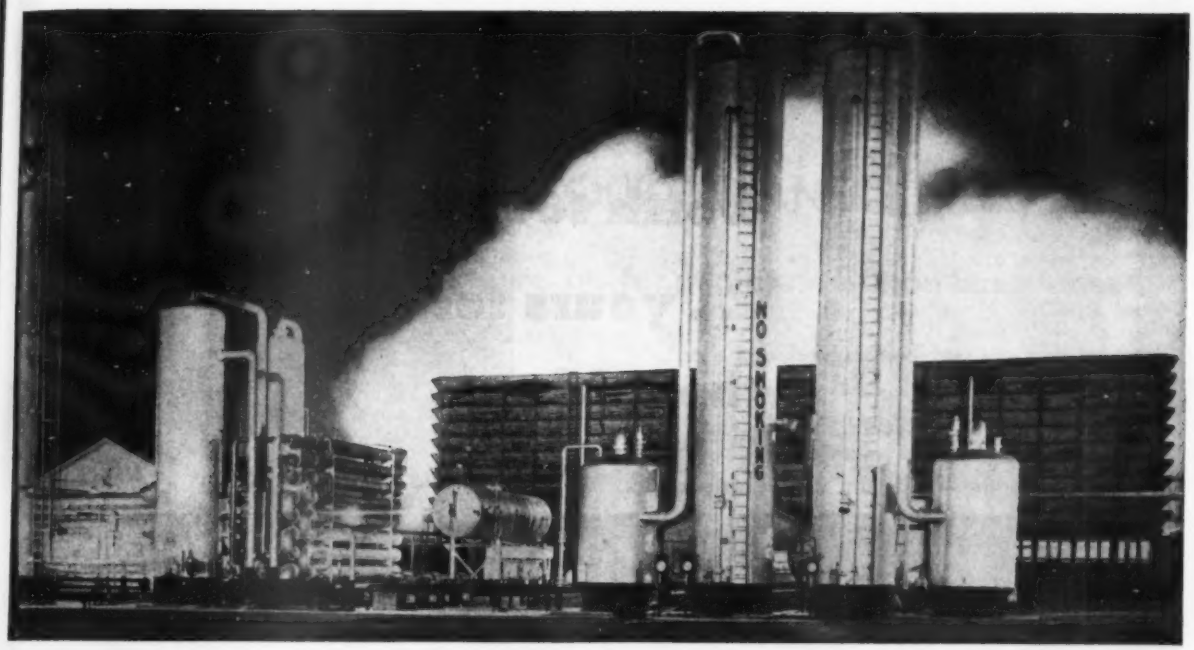
Specialists in the manufacture of PERMANENT MAGNET MATERIALS



FOR INDUSTRY

Carbon Black
Natural Gas
Natural Gasoline
Pumping Equipment
Pine Tar
Charcoal

The first step in the manufacture of two Cabot products takes place in plants like this, in the Pecos River country in West Texas.

First, Cabot strips natural gas of its natural gasoline, which is used to enrich aviation and other special motor fuels.

Next, Cabot takes this same gas and burns it for the manufacture of its own superior grades of carbon black, all of them essential to the rubber, paint, lacquer, enamel, ink, paper and plastics industries.

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Modern pumping system for evaporating substances under test in research on Selenium Rectifiers.

Westinghouse Selenium Rectifiers are not an overnight development. Before the present process was adopted, more than 9 years of continuous research—at a cost of more than 100,000 dollars—was spent in testing of foreign and domestic types and processing experiments.

The result has been a Selenium Rectifier comparable in quality to Rectox Rectifiers . . . long recognized as having a longer life and greater dependability than any other type of metallic rectifier.

For instance: In a comparative test with other Selenium units under identical conditions—and at full rating—Westinghouse Selenium Rectifiers showed an increase in forward resistance of less than one-half that of the best units tested, indicating a longer life than any Selenium Rectifier now available.

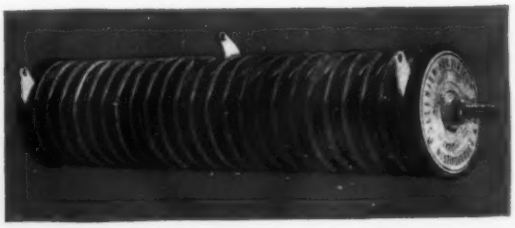
No other Selenium Rectifier unit is backed by such an intensive research program, justifying our claim that Westinghouse Selenium Rectifiers are unexcelled where long life and dependability are prime factors.

These new Westinghouse Selenium Rectifiers are ready for the market now. If you're a user of Selenium Rectifiers you can take advantage of this investment in research by outlining your requirements to a Westinghouse representative. Or write your nearest Westinghouse office for all the facts. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-21382

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Selenium Rectifiers



NEW

XOA Socket with XOS-3 Shield and Shield Base

XOA Socket

XOR Socket

XOS-1 Shield for 1 3/16" high tube body (6AK5 type)

XOS-3 Shield for 2" high tube body (OA2 type). Also available: XOS-2 for 1 ½" high tube body (6C4 type)

Shield Base for XOS-1, XOS-2 or XOS-3

SOCKETS AND SHIELDS...

for miniature button base tubes

These new National sockets are of mica-filled natural molded Bakelite with silver-plated beryllium-copper contacts — designed for maximum dependability and adaptability. The contacts — either axially or radially mounted and removable for replacement — provide short leads and low inductance so vital to ultra-high frequency design. Sockets are built to JAN specifications — can be used with or without shields.

Made in three sizes to accommodate the various sizes of miniature tubes, the shields are of nickel-plated brass, with cadmium-plated phosphor bronze spring to provide correct tension to hold both tube and shield in place regardless of angle or vibration. Shield bases are of nickel-plated brass, with two 4/40" spade bolts mounting both socket and shield base.

You'll find hundreds of other parts, both new and old, to improve your apparatus in the new 1947 National Catalog.

National NC EST. 1914

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MALDEN, MASS.

MAKERS OF LIFETIME RADIO PRODUCTS

for GRINDER, LATHE or BENCH

Here's a Rotary Chuck (9" dia.) with many unique features. Does not heat the work . . . no electricity . . . no work thrown off. Holds tightly for light cuts on lathes and on thin work for light machining. Can be clamped to bench for testing or inspection work. When you buy a ROTARY get *ALL* these and other advantages . . . buy a Brown & Sharpe. **Rectangular Models** (5 sizes from 2 7/16" x 5¼" to 12⅛" x 36") and other Permanent Magnet Holding Tools also available. *For sale only in the United States of America and its Territories. Write for illustrated catalog. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.*

B·S *We urge buying through the Distributor*

BROWN & SHARPE
PERMANENT MAGNET CHUCKS

HEVI DUTY

Hevi Duty Electric Co.
Surges Transformers

With the acquisition of the Surges Electric Company of Milwaukee, Hevi Duty can now offer quality dry type air cooled transformers with or without tap changing switches as well as special transformers for special requirements. An accelerated program of modernization will present opportunities for increased production and good delivery schedules.

Write for Bulletin S-4611

HAROLD E. KOCH '22, *President*
ELTON E. STAPLES '26, *District Manager, Cleveland*

HEVI DUTY ELECTRIC COMPANY
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THE TABULAR VIEW

Still Time.— Admonishing engineers to take the lead in finding solutions to the many questions which will naturally arise with the necessity of protecting our key industries, S. PAUL JOHNSTON, '21, recounts (page 398) the havoc which befell the Japanese who learned too little too late. Admittedly, the picture which Mr. Johnston paints, as a result of his studies in Germany and Japan during 1945 when he was deputy director of the aircraft division of the United States Strategic Bombing Survey, is not a pleasant one, but the consequences of unpreparedness are tragic. Since World War I, Mr. Johnston has long been active in the aviation industry, about which he writes with authority. Mr. Johnston expresses only his personal view in this issue, of course.

American Food Basket.— Changes in the customs and taste habits, the increased standard of living, and education and promotion are the factors largely responsible for the change in contents in America's food basket over the past half century for which reliable records are available. Such, at least, are the conclusions of FREDERIC W. NORDSIEK, Editorial Associate of The Review, whose authoritative and penetrating article (page 401) outlines the general pattern of food consumption of the American family, and traces in detail the rise and fall of three important staple foods in this country over the past five decades.

Unclogging Polyglottism.— Teaching graduate students to read technical literature in a foreign language with a saving of as much as 30 per cent of the time usually required for such mastery is but one of the results recently achieved in the Institute's Department of Modern Languages. Development of proper pronunciation of foreign languages through the use of speech recording apparatus, which enables the student to compare his lingual achievements with those of foreign language records, is another, as WILLIAM N. LOCKE, head of the Department of Modern Languages tells (page 405).

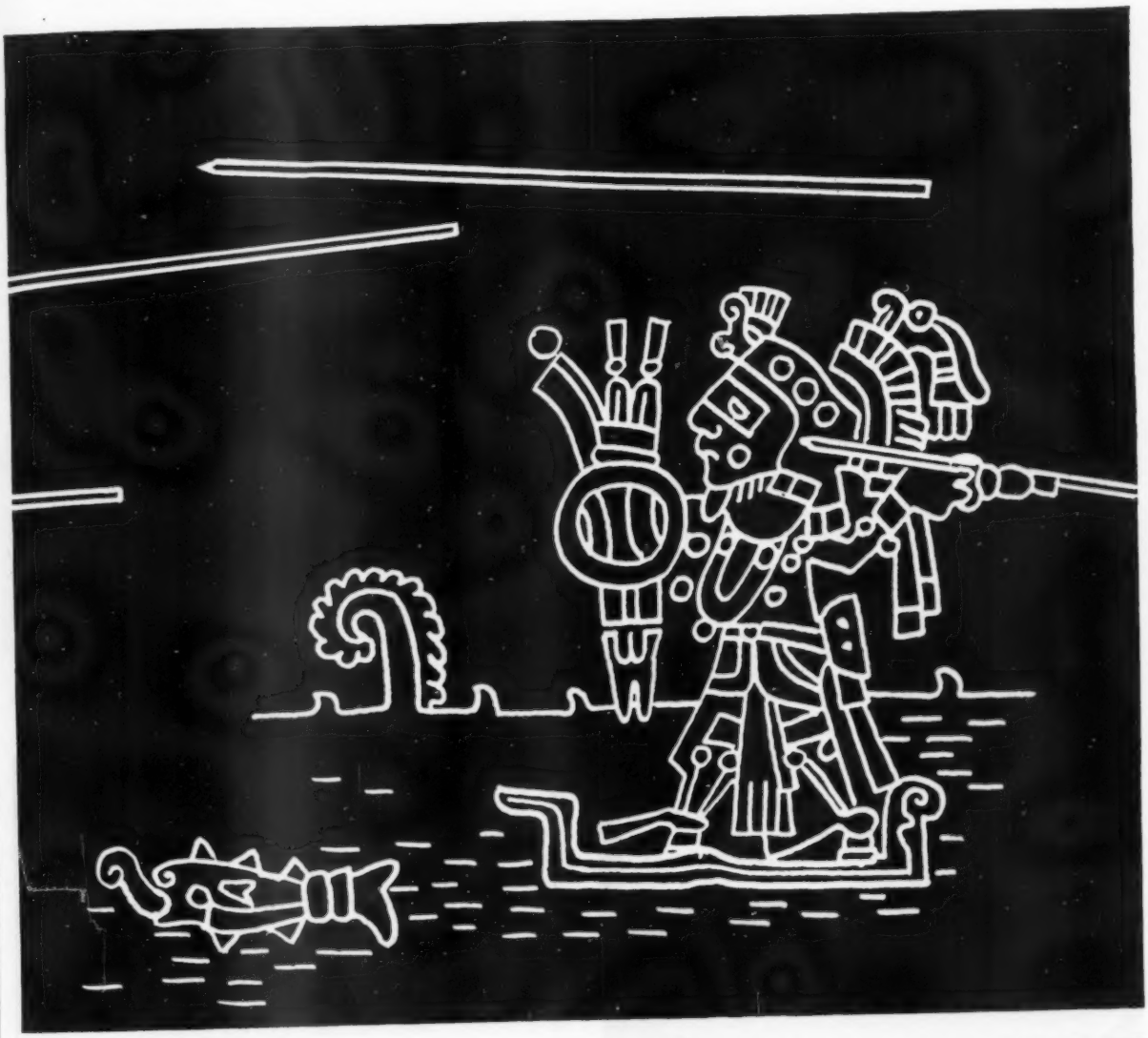
For a New Science.— Plea for the development of organization as a true science is the nub of the message (page 408) made by ALVIN BROWN, Vice-president for Finance of the Johns-Manville Corporation. As an Alfred P. Sloan Visiting Lecturer at the Institute, Mr. Brown took pains recently to elucidate the opportunities for today's students in elevating organization to the status of a true science. In 1933, Mr. Brown served in Washington as assistant to the director of the Federal Budget, later becoming assistant administrator and executive officer, and finally review officer of the National Recovery Administration. In 1937 he became vice-president of the West Virginia Coal and Coke Corporation and in September, 1946, was appointed to his present position.

Pioneer.— From a busy program in the Office of the Secretary of War, DR. EDWARD L. BOWLES, '22, takes time out to pay tribute (page 397) to an early telephone pioneer whose contributions have done much to advance this country to the position of the world's largest user of wire transmission of the human voice.

HOW TO MAKE AN ARM GROW

A human arm can throw a spear only so far. But some ancient genius of an engineer figured out that, by employing a throwing stick, which the Aztecs called *atlatl*, the lever of the human arm —and the distance achieved—could be extended, with quite pointed results for an enemy.

Specifying molybdenum in steel is something like using an *atlatl*. For molybdenum extends the usefulness of good steel. By providing good hardenability at low cost, molybdenum steels permit modern engineers to save weight—and costs—in design. It pays to specify molybdenum.



MOLYBDIC OXIDE—BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"
CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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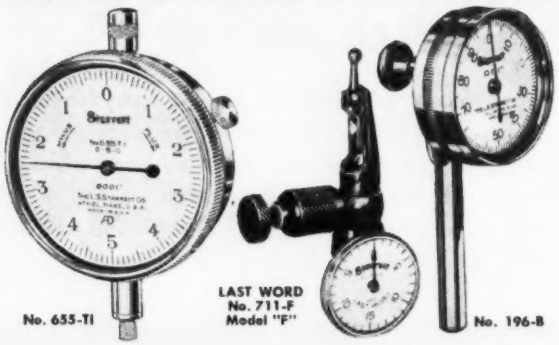
MOLY

THREE STARRETT LEADERS



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A DEPENDABLE
PERFORMER

Performance records on all Diefendorf installations testify to the long, dependable life of precision-made gears. Every Diefendorf gear is designed and precision engineered for its particular job.

Diefendorf Gear Corp.
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Syracuse 1, New York

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★★★★★ GEARS

MAIL RETURNS

It's Spring Again!

FROM S. ALBERT KAUFMAN, '19:

In the July, 1945, issue of The Review an article, by Irwin W. Sizer, relating to poison ivy brought out the effectiveness of oxidizing agents, such as potassium permanganate and ferric chloride.

As a surveyor, I naturally am in contact with plant growth of all kinds and have had to combat skin itchiness. In July, 1945, while surveying in Stoneham, I was in contact with poison ivy. My skin, blotched with the resulting growth, was within a week successfully treated with tincture of ferric chloride. Last August, in Malden, a similar attack on my skin was within a week abated by tincture of ferric chloride. On February 14, 1947, I surveyed in Wakefield where I had to cut some brush to locate boundaries. The next day both of my wrists were covered with a skin growth and accompanied by the usual itching. I applied tincture of ferric chloride and within a week the growth on the skin was completely destroyed, and with the exception of a little coloring on the skin, I am none the worse for the experience.
Malden, Mass.

Addendum

FROM IRWIN W. SIZER:

In agreement with Mr. Kaufman's experiences, I can say that oxidizing agents, such as ferric chloride or potassium permanganate, have proved very useful in the treatment of poison ivy dermatitis in its earliest stages. After the poison ivy toxicants have penetrated beneath the skin, they are without beneficial effect, but so is everything else which has been tried.
Lexington, Mass.

Historical Contribution

FROM CARLTON E. TUCKER, '18:

The Alexander Graham Bell story on page 267 of the March, 1947, Review, may have contained even more interest to Review readers by addition of the fact that we have in the M.I.T. historical collection the Reis telephone as well as a number of Bell models which were undoubtedly used by Professor Cross in the 1892 legal suits mentioned. We also trace the development of the telephone through the years, showing early commercial instruments as used in the summer of 1877, the competing instruments of Edison, Berliner, Phelps, Gray, and Dolbear. Later instruments as devised by Blake, Hunnings, and White are also in the Institute's collection.
M.I.T., Cambridge, Mass.

Postscript

FROM W. MACK ANGAS, '17:

My belated request for the addition of a parenthetical foreword to

(*Concluded on page 428*)

Speed with Economy

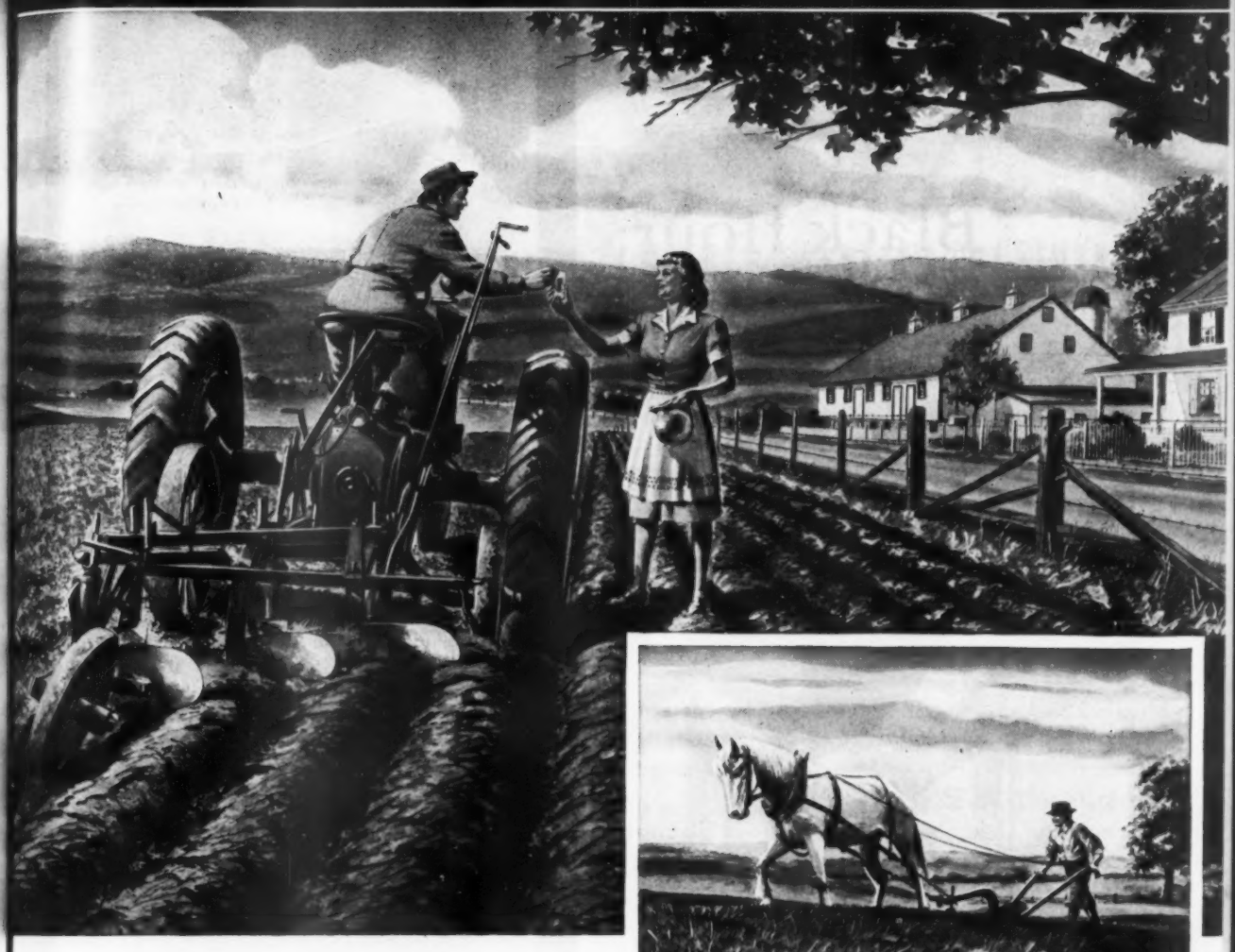
We have recently completed
our 9th contract for
MACHLETT LABORATORIES, INC.

whom we have had the pleasure
of serving since 1933

W. J. BARNEY CORPORATION
101 PARK AVENUE, NEW YORK

INDUSTRIAL CONSTRUCTION
Alfred T. Glassett '20, Vice President

"What is all knowledge . . . but recorded experience?"—CARLYLE



Why some things get better all the time

HEALTH, strength and zest for life—of youngsters, of workers, of all of us—depend on food. Food produced by the millions of tons yearly. And each year our farmers have *more efficient means* to do their tremendous job.

The modern farmer has a tractor, a truck, and uses specialized farm tools—all with parts made increasingly of alloy-toughened steels and of plastics, for sturdier, more efficient service. His milking machine has parts of rust-resistant stainless steel. Chemically fortified feeds grow healthier livestock. New chemical sprays protect his crops from insects and plant diseases. And improved fertilizers restore vital elements to his soil.

From care of the life-giving soil to precious harvest, the farmer's means for food production are steadily improving . . . because into these means go *better and better materials.*

Producing better materials for the use of science and industry and the benefit of mankind is the work of UNION CARBIDE.

Basic knowledge and persistent research are required, particularly in the fields of science and engineering. Working with extremes of heat and cold—frequently as high as 6000° or as low as 300° below zero, Fahrenheit—and with vacuums and great pressures, Units of UCC now separate or combine nearly one-half of the many elements of the earth.

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LINDE OXYGEN • PREST-O-LITE ACETYLENE • PYROFAX GAS • BAKELITE, KRENE, VINYON, AND VINYLITE PLASTICS
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Black flour

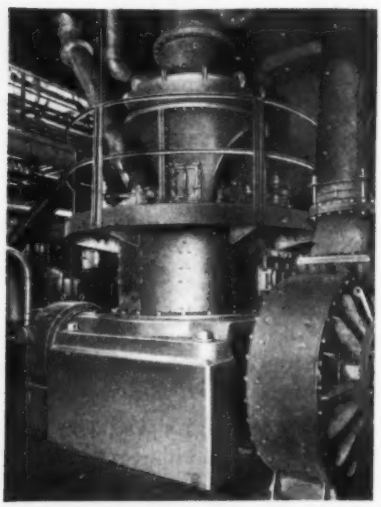
A MAN once looked at this substance and asked, "What is it, black flour?" Actually he was looking at coal . . . ground to about the fineness of flour — pulverized coal.

That was nearly 30 years ago when C-E engineers first demonstrated that powdered coal, as it was then called, was a practical and highly advantageous fuel for firing boilers. Today it is the generally accepted method of firing large power station boilers and is widely used for boilers in the middle-size range.

But pulverized coal firing proved to be something more than just an improved method of burning coal. It opened the way to other important developments such as the water-cooled furnace, the use of preheated combustion air and the designing of boilers far larger than had been considered practicable. In all of these developments Combustion Engineering had a major part.

The total contribution of pulverized coal firing to the national economy cannot be accurately calculated, but it is conservative to say that in coal savings alone it amounts to millions of tons annually.

B-122



C-E RAYMOND BOWL MILL — ***Today's most advanced design of coal pulverizer — a standard component of the C-E Pulverized Coal System.***

These three factors are the unwritten plus-values in every C-E contract —

Knowledge — *to solve today's, and tomorrow's, steam generating problems.*

Experience — *to interpret, from a world-wide background in every important industry, the specific needs of each installation.*

Facilities — *to manufacture complete steam generating units for every requirement, from 30 boiler horse power up to the largest.*

C-E

COMBUSTION ENGINEERING

200 Madison Avenue, New York 16, N. Y.

Sandee

FLEXIBLE VINYL EXTRUSIONS

Materials: 1. Polyvinyl Chloride
2. Copolymer Vinyl Chloride — Vinyl Acetate

SANDEE extruded flexible vinyl tubings and shapes served admirably during the war. Now, in peace, Sandee extruded flexible vinyl items are also serving admirably, but in many additional and diversified functional applications.

Flexible vinyls are excellent electrical insulation materials, are extremely tough, wear resistant, moisture, chemical and solvent resistant and in addition provide beauty of color and finish for many applications.

Electrical insulation tubing, carrying straps, mattress handles, garden hose, bumper sections, gaskets and many other successful applications indicate the versatility of this excellent material.

Study the material property chart on these materials and consult Sandee for aid in design and selection of proper formulation to satisfactorily meet your requirements.

OUTSTANDING PROPERTIES OF SANDEE FLEXIBLE VINYL MATERIALS

1. *Specific Gravity —1.22 to 1.42*
2. *Tensile Strength —2000 to 3000 p.s.i.*
3. *Dielectric Strength, Short time 1/8" V.P.M. — 250 to 450*
4. *Low Temperature Flexibility ° F—0° to -85°*
5. *Water Absorption —Nil*
6. *Burning Rate —Nil*
7. *Odor —Faint to none*
8. *Resistance to Chemicals —Excellent*
9. *Resistance to aging —Excellent*
10. *Color —Unlimited*
11. *Finish—Satiny or high gloss*

SALES REPRESENTATIVES IN 19 PRINCIPAL CITIES

Sandee Manufacturing Company

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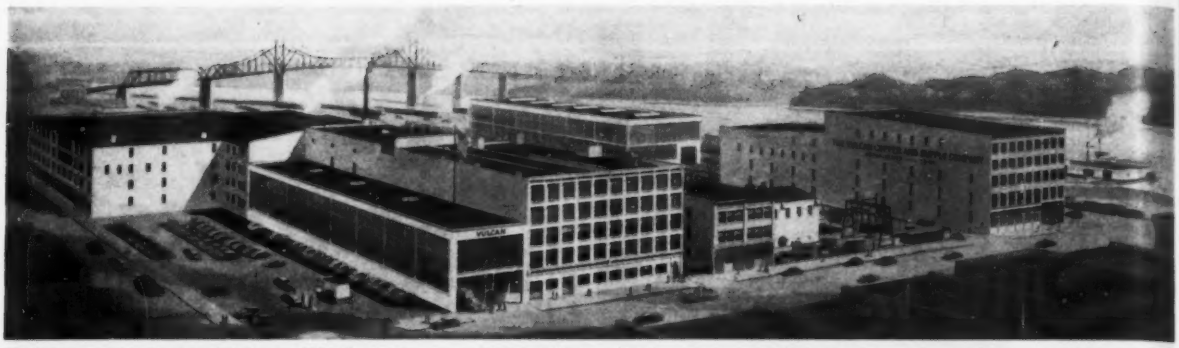
EXTRUDED PLASTICS AND SPECIAL TOOLS



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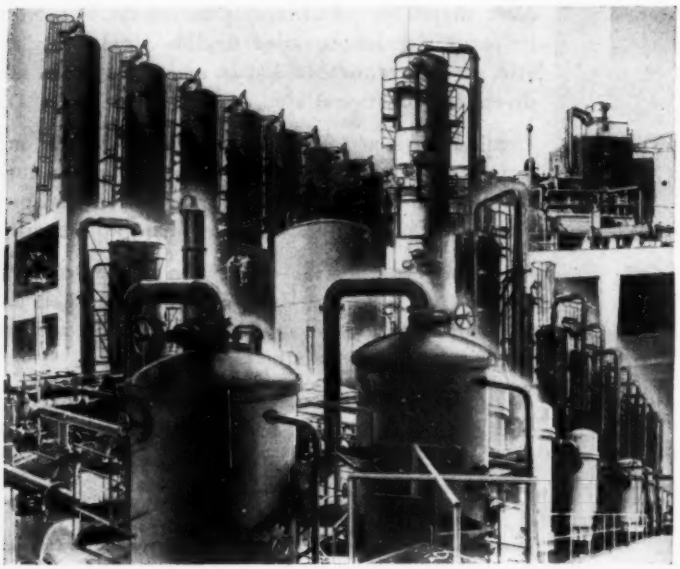

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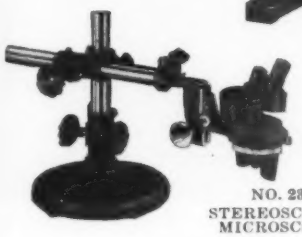

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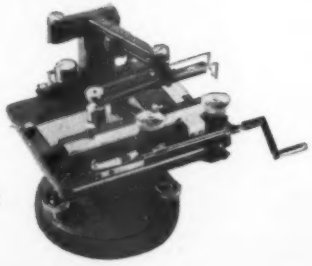

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VOLUME 49 NUMBER 7

THE TECHNOLOGY REVIEW

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EDITED
AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Whoopee!!

CONTENTS for MAY, 1947

THE COVER — ESCAPEMENT
From a photograph by Harold M. Lambert

NUUANU PALI — FRONTISPIECE — 394

TELEPHONY IN ITS PIONEER ERA — BY EDWARD L. BOWLES — 397

NIPPONESE NIGHTMARE — BY S. PAUL JOHNSTON — 398
Points the Way to Early Preparation in Industrial Preparedness

AMERICA'S CHANGING FOOD PATTERN — BY FREDERIC W. NORDSIEK — 401
Current Food Habits Differ from Those of Half a Century Ago

LICKING THE LANGUAGE PROBLEM — BY WILLIAM N. LOCKE — 405
New Approaches in the Teaching of Modern Foreign Languages

ORGANIZATION — A NEGLECTED SCIENCE — BY ALVIN BROWN — 408
With Vigor, Opportunity Knocks in the Managerial Field

☆ ☆ ☆

THE TABULAR VIEW — 384
Contributors and Contributions

MAIL RETURNS — 386
Letters from Review Readers

THE TREND OF AFFAIRS — 395
News of Science and Engineering

THE INSTITUTE GAZETTE — 411
Relating to the Massachusetts Institute of Technology

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Official Photograph, U. S. Navy

Nuuanu Pali, pass across the mountain ridge separating Honolulu from Oahu

THE
TECHNOLOGY REVIEW

Vol. 49, No. 7 May, 1947

The Trend of Affairs

A Whale in Every Pot?

FEW persons would characterize the British as being given to overexaggeration, or as being skilled players in the great American game of "bigger and better." Yet, research now in progress by the Department of Scientific and Industrial Research in London is of the kind that dwarfs the American slogan for a chicken in every pot, for the Department is conducting experiments in arctic whaling to determine whether lean whale meat can be utilized for human consumption on a wider scale than heretofore.

In whaling, certain general principles of slaughtering the mammals for meat and handling the carcasses can be followed only with great difficulty. One of the greatest practical difficulties is rapid cooling of the carcass immediately after death. Because of the very considerable bulk of the whale carcass and the thickness of the layer of fat under the skin, cooling takes place very slowly. Indeed, the whale's blubber provides an excellent natural system of thermal insulation which enables the mammal to thrive in cold waters and which is the reason why its meat is likely to go bad rapidly, without prompt and effective refrigeration. The time between death and butchering on the deck of the factory ship may vary considerably, so that some method of cooling the carcass as soon after death as possible is exceedingly desirable.

Scientists on the whaling factory ship, *Balaena*, recently conducted experiments to test a likely method of more or less natural refrigeration for the preservation of whale meat. An advantage of the method is that it requires but slight modifications from normal procedure of whaling. When a whale is caught, its carcass is normally inflated with air to prevent sinking. This causes the whale to roll over on its back and float belly uppermost. In the refrigeration experiments, portions of the skin and blubber were removed, as soon after death as possible, to admit cold sea water which had a temperature of 30 degrees F.

Machine versus Man

THE Japanese still make appreciable amounts of quality papers by hand processes that have changed little during the past 10 centuries. The fibers for Japanese handmade papers are derived from the barks of three native shrubs. The bark is stripped from the shrubs and fibers are derived from them by painstaking hand operations. From a mash of wood fibers in water, which is inserted in a screen or bin through which the water flows away, the paper is produced by a shaking operation which knits the individual fibers together in a closely intermingled mat. Using such primitive hand operations, it has been estimated that one Japanese papermaker can make as much paper in one year as can be produced by a relatively modern papermaking machine in about 20 minutes. The production rate of the machine is therefore something like 7,200 times that of hand labor.

Possibly hand operations in the manufacture of paper might be adequate to meet Japanese needs. Possibly also, in this country, we have come to regard paper as a readily available and comparatively inexpensive commodity with almost unlimited uses. But the 150,000,000 people in the United States and its territories and possessions representing about 7% of the world's population, consume 72% of the world's paper production. Such a record of consumption could never be achieved so long as manufacturing operations depended on manual operations alone.

Forest Farms

CURRENT figures from the Department of Agriculture's Forest Service indicate that we are still cutting lumber faster than it is growing. In board feet, the forests of this country have been reduced to less than half their original content, and the finest, most accessible stands have long since gone except where protected by state or federal governments. Secretary of the Interior Krug has declared that about the only area on the North American

mainland which can now support newsprint or kraft-paper development on a perpetual basis is Alaska. Fire and disease have probably taken a heavier toll than man, but the conservationists can still make the point that a primary national resource is being drained at a faster rate than it is being replenished.

Since the essence of the problem can be stated in simple arithmetic, it has long been understood. There are also signs that corrective steps are now gaining sufficient momentum so that the Forest Service's dream of a perpetual forest reserve may achieve reality. The concept of a forest on a continuing basis was put into practice in Europe long ago, although conditions frequently made it impossible to maintain sufficient wooded area for a country's needs. One rayon manufacturer has used the financial pages of at least one newspaper to announce that the forest lands reserved for it by the province of British Columbia will be self-perpetuating through scientific management and planned afforestation. Whatever the reasons for such advertising, the fact remains that many privately owned and nationally protected forests in this country are also being cut and replanted (or allowed to reseed) so that the total lumber "capital" remains undiminished. As might be expected, the small owners as a class, with less to gain, have not been so quick to do likewise. Because their total holdings represent about half of our forest acreage, increasingly intensive efforts are being made by government agencies and large users of wood to educate this group in the methods and benefits of a stable forest. Only recently, however, has the economic situation in this country begun to make it generally profitable for farmers, as well as for lumber companies, to treat wood lots and forests as a continuing source of income rather than as a mine to be exhausted in one sweep.

The factors that are encouraging the growing of trees as a farm crop are partly technical. When logging railroads (with a construction cost of $25,000 per mile and high operating expenses in addition) were the only means of moving logs to the sawmills and a donkey engine was used to assemble the loads, only high-grade lumber could be handled profitably. A stand had to be thick with large trees to attract loggers. But roads suitable for trucks can be built with modern earth-moving equipment at about $1,500 to $5,000 per mile. Tractors, skidpans, and Diesel trucks have combined to lower transportation costs further, and selective cutting is now feasible on stands that produce about one-fifth the number of board feet once thought necessary for profitable operation.

Small, semiportable sawmills, such as were used by the armed forces during World War II, are another important aid to the farmer-forester, for with them it is feasible to make many setups, each for a comparatively small run of lumber.

There is now a market for a larger number of species and for smaller trees than was formerly the case. The owner of a wood lot near a pulp mill can sell quite small trees if cut to size and delivered to the mill. Selective cutting produces many small logs, since trees must frequently be cut when far from full-grown if they are diseased, unfortunately placed, or otherwise defective.

Just prior to the war, state nurseries were producing seedlings at the rate of almost 100,000,000 per year. Since 1935, part of these seedlings have gone into a shelter belt that, it is hoped, will eventually stretch from North Dakota through Texas, approximately along the 100th meridian. This is all potential Dust Bowl country, and the reason for the shelter belt is to protect and hold down the soil against wind erosion. It is estimated that eight to ten acres of trees will protect a farm of 160 acres. To date, well over 200,000,000 trees have been planted on about 30,000 farms. Other large users of seedlings are open strip and pit coal mines, particularly the former. The trees used to cover the spoil banks which remain after strip mining is completed frequently grow faster on the raw dumps than on undisturbed ground. In Illinois, which state leads in the production of coal by strip mining, operators planted more than 8,000,000 trees between 1938 and 1943. In Pennsylvania, the state nurseries have distributed more than 15,000,000 trees to mining companies since the start of that practice in 1899. These figures are sufficiently large to sound quite impressive, but in Illinois, for example, only 8,466 acres had been forested by the end of 1943.

Photo by Wynne Bullock-Artes

The conservationist can still make the point that a primary national resource is being drained faster than it is being replenished.

There appears to be about 75,000,000 acres of marginal and submarginal land in this country that is suitable for reforestation. At the present rate of planting, it would take centuries to finish the job. This is the basic reason for the Forest Service's proposal that the state nurseries should raise their output to one billion seedlings per year. The country is fortunate in that we still possess sufficient wooded or potentially wooded area to permit, with foresighted treatment, a continuous drain at our normal rate of production of from 30,000,000 to 40,000,000 board feet per year. Still, with increasing production and continuing higher standards of living, we need to make every effort to conserve — and, wherever possible, replenish — our natural resources, once believed to be inexhaustible but lately shown to be quite otherwise.

Telephony in Its Pioneer Era

By Edward L. Bowles

THE passing of Hammond Vinton Hayes, '85, in Boston, on March 22, 1947, brings to a close the life of a scientist and engineer who conspicuously influenced the art of telephony. In 1885, after receiving the second doctor's degree to be granted by Harvard University in the field of physics, Dr. Hayes joined the staff of the American Bell Telephone Company in Boston as head of its laboratory. This was at a time when what is now the vast Bell System was in the making; a time when the outcome of the efforts of Bell and his New England supporters was in grave doubt. Bell's invention of the telephone had been made a decade earlier. Some five years had elapsed since a settlement had been made with the Western Union Company — the Bell Company's only competitor — in which it was agreed that the Western Union would keep out of the telephone business for a period of 17 years. But three years before that, this same company had turned down the Bell rights offered to them for $100,000. The rights of Thomas A. Edison, Emile Berliner, Stephen Gray, Daniel Drawbaugh, and others were being contested. Bell's backers, Gardiner G. Hubbard and Thomas Sanders, were busy with organizational problems and James J. Storrow was deep in the complexities of litigation in their behalf.

It was in this dramatic and portentous setting in the early days of telephony that Hayes found himself when he joined the telephone organization. Having studied under Professor Charles R. Cross, '70, at M.I.T., who was retained by the Bell interests, Hayes was soon involved in the intricacies of what was then a crucial patent litigation.* He was faced with the problem of evaluating inventions and improvements rapidly coming to the fore in this initial rush of telephonic development. Limitations of the telephone as a commercial instrumentality were rapidly becoming apparent. For example, the distance over which articulate speech could be transmitted made long-distance transmission impossible. Wagons, delivering cells to replace worn-out batteries at the subscribers' sets, were falling apart in the street because of the corrosive action of electrolytes. There were other seemingly insurmountable problems, aggravated by the unprecedented rate of growth of interest in telephone service.

Photo by Wynne Bullock-Artco

The finest, most accessible stands have long since gone except where protected by state or federal governments.

It was on Hayes's shoulders that these current burdens fell. But he had also a far greater and less obvious load to carry in the planning and administration of a program of research and development to anticipate the problems yet to come and to ensure the future of the telephone business. In 1888, Hayes installed an isolated telephone system in the offices of the American Bell Telephone Company in Boston, using a central battery of a large number of cells to replace individual batteries in the homes of subscribers, and described such a system in a patent dated December 25, 1888. It was through Hayes's imagination, drive, perseverance, and leadership that the single central office battery replaced the individual batteries in the subscribers' telephone instrument. This was one of the greatest single contributions to be made in the early commercial use of telephones after the Edison microphone made a startling improvement in the Bell device by introducing the phenomenon of amplification. By direct contributions of Hayes and his staff, this microphone was developed into a practical device — the solid back transmitter. Another contribution which Hayes made in the pioneer days of commercial telephony was the "heat coil" — which would now probably be known as a thermally operated switch — for the protection of delicate telephone apparatus against stray currents.

Hayes not only directed the attack of these problems but he contributed significant inventions. Under his guidance was the attack on these subtle problems which limited the distance over which speech could be transmitted. One of the needs was for means which would rejuvenate or amplify speech as it became attenuated in traveling toward its destination. Another was for a technique which would overcome the tendency of telephone lines, and particularly cables, so to alter the quality of the transmitted speech that even though its volume were adequate the distortion might render it unintelligible. Hayes maintained a group to work constantly on the development of means of amplification to devise what, in telephone parlance, are known as repeaters. It was through this pioneer effort that the distance of successful transmission was extended from New York as far west as Chicago in 1892, and to Denver in 1911. This work on electro-mechanical repeaters paved the way for the application to this task of the modern electron-tube amplifier which further extended the range of wire telephony to transcontinental distances in 1915.

It was Hayes who selected Dr. George A. Campbell, '91, to work on the problem of overcoming the distortion of speech in transmission. Campbell, like Hayes, was a brilliant, highly educated man. (*Concluded on page 436*)

* Additional data on the importance of this suit and the part which Cross played in the early stages of telephone development were published in the March, 1947, issue of The Review, pages 267–269.

Nipponese Nightmare

By S. Paul Johnston

FOR almost a year and a half I was in the junk business. As chief of the aircraft division of the United States Strategic Bombing Survey, my job was to investigate, *in situ*, what had happened to the once great aircraft industries of Germany and Japan. I mention the junk business advisedly, for junk was all that remained of Focke-Wulf's great production chain in Northwest Germany, of the Fieseler and B.M.W. factories at Kassel, of the vast Messerschmitt complex in the Augsburg-Regensburg-Munich triangle, and of every other known plane or engine factory of any consequence in Hitler's former domain.

In Japan, the situation was the same, but worse. Airplane and engine plants that had approached Willow Run in size and in activity (although never in production), Mitsubishi of Nagoya, Nakajima at Tama-Musishino, and Kawanishi and Kawasaki in the Osaka area, were reduced to gaunt skeletons. Out of these colossal boneyards we pieced together what we could of information that might be of value to the future of our own air industries.

The full story of the conclusions reached by the Bombing Survey in the several industrial fields will be found in a voluminous series of reports already published, or in the process of publication, in Washington. The purpose here is to scan briefly one phase of the findings in Japan, the underground dispersals of the aircraft industry, to point out a lesson that is of vital importance to American industry today.

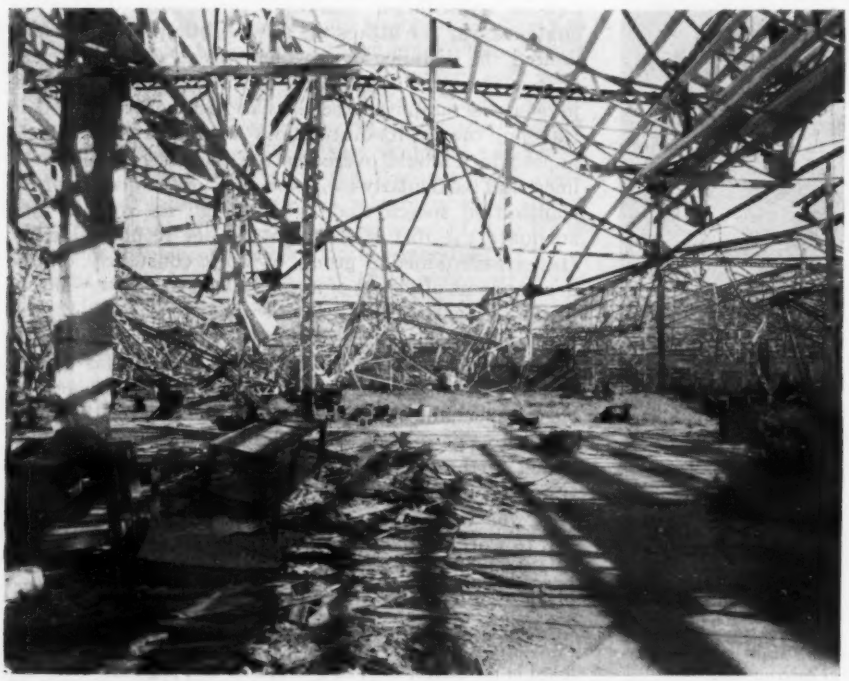
As human beings, we hope that war will never come to our shores. As realists, some skepticism on this score appears warranted. As engineers, we must plan what to do about it, if, as, and when it comes. Regardless of circumstance, we must have the required knowledge and ability at our disposal. We cannot afford to do as the Japanese did — learn too little, too late. Our future situation will never be comparable to that faced by the Japanese Empire in the summer and fall of 1944, but there are lessons to be drawn, and obvious mistakes to be avoided. Let us look at the evidence.

By midsummer of 1944 the Japanese aircraft industry found itself swaying precariously on the horns of a dilemma. As a result of a great drive for production by the Munitions Ministry, many factories found their shelves almost bare of certain essential items.

Production on Paper

The well-known "numbers racket" was operating, as it did elsewhere, even in these United States. Each month's production statistic *must* be better than that of the month preceding, so, — all available bits and pieces were put together into an approximation of finished articles, counted, and pushed out of the factory doors. Sometimes months elapsed before such aircraft could be made operational — but that was not immediately important to the statisticians!

The statistical method works well as a production incentive scheme so long as production programs are backed up by adequate planning. But in Japan both the long- and short-range planning for aircraft production fell far short of the minimum.



The huge on-the-surface Japanese aircraft plants were reduced to gaunt skeletons by United States strategic bombardment. This illustration gives a typical example of conditions found by the Bombing Survey. Note the complete absence of machine tools.

Out of the rubble and dust of what was once the Japanese aircraft industry comes a lesson that is pertinent to the future well-being of the United States: *If we must eventually put our key industries underground, we need to find out how to do it now.*

The pulling and hauling by the Imperial Army and Navy for essential matériel and equipment, although eventually somewhat improved by the efforts of the Munitions Ministry, created an impossible situation in the aircraft industry. We had our own troubles in co-ordinating Army and Navy requirements, but by comparison, the Japanese operated at a comic-opera level, — strictly Gilbert and Sullivan. Shortages developed that could not be met. Essential parts for production lines turned up missing. Spares and replacements for operating units in the field were seldom at the right places at the right time. Basic material stocks dwindled. The rarer alloying materials, needed for high strength steels for high performance aircraft engines, all but disappeared, making many design and tooling changes inevitable. Neither replacements nor substitutes were to be had due to the effective blockade imposed by our Navy and our Air Forces. During most of 1944, although great quantities of such essential materials existed in Japanese-held territories, only driblets reached the Home Islands. By January, 1945, the supply was cut off completely.

At the same time, the labor situation had become extremely critical. The demands of the Japanese Army for troops to pour into China and into the beleaguered islands of the Southwest Pacific drained off practically all able-bodied man power. Mainly women, children, high school students, and the aged and infirm were left to man the great aircraft plants in Nagoya, Osaka and Tokyo. As a result, the output per worker per day in terms of finished aircraft (never a very high figure) dropped almost below the level of visibility.

Then, to top it all, Saipan, the impregnable gateway to the Empire, fell to the advancing American forces.

The loss of Saipan was a rude shock to all Japanese industry. "Higher ups" could nôt have failed to foresee the handwriting on the wall, but until then the average Nipponese still believed that his "undefeated" navy would keep the American bombers at more than arm's length. Although orders for the dismantling and underground dispersal of key industries had been on the books for many months, the belief that the Home Islands were unreachable was so firm that they were generally ignored. Further, few adequate plans for execution appear to have been made.

Wrong Answer to Dilemma

Here, then, was the dilemma. Things being as they were, would it not be better to continue to ignore dispersal orders and try to patch up a rapidly deteriorating industrial condition in the hope of producing enough aircraft to keep back the invaders from the ramparts? Or, would it not be the better part of valor to scurry underground as fast as possible to protect the essential tools of industry against possible attack, so that the war could be continued even if most of the on-the-surface facilities were destroyed?

To this basic question the Japanese came up with the wrong solution. He elected to ignore the threat in the hope of satisfying the demands of the immediate future. But he failed miserably. During the fall of 1944 aircraft production went from bad to worse. Fewer and fewer planes were

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Typical tunnels driven through the relatively soft volcanic rock in Japan. Ground is easily worked by hand tools and is strong enough to be self-supporting for galleries of reasonable dimensions. Most of these tunnels were excavated by captured labor under Army supervision.

▼

delivered to the Emperor's hard-pressed squadrons. Units in the field watched essential supplies of spares dwindle to a trickle and finally disappear altogether. By mid-December, when the first heavy B-29 raids took place, the output of Japanese aircraft had dropped to a level below that of January, 1944, and the rate-of-production curve was dropping faster than it had risen a year before.

The first raids by the Marianas-based B-29's of the 20th Air Force, really finished the Japanese aircraft industry. They sounded the gong that started the panic, and the long-deferred dispersal began. The Urgent Dispersal of Plants Act of February, 1945, made such action mandatory. Like ants struggling to remove their valuables from a broken hill, the Japanese began to scatter aircraft production into the mountains. As fast as they could, they dismantled their plants. By rail, by road, by horse track and footpath — on wheels, on rollers, and on human backs — they made desperate efforts to save their precious production tools by getting them underground, — any place, but always underground. They themselves accomplished at least half of the job that our big bombers had set out to do. By destroying their own aircraft industry they committed industrial hari-kari.

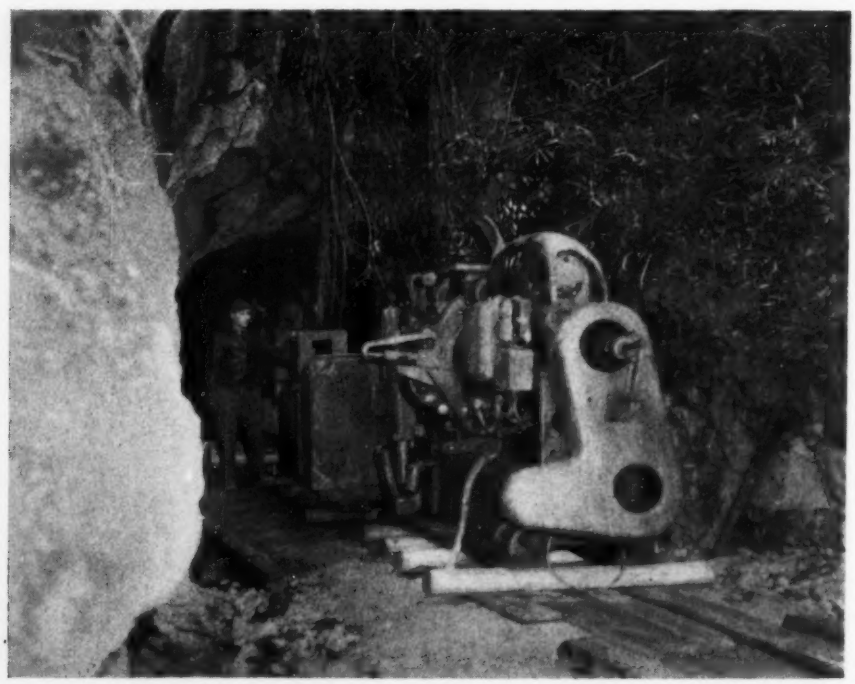
Few people realize the extent to which the Japanese industry went underground. In the course of investigations made in October, November and December, 1945, as a part of the work of the United States Strategic Bombing Survey, some 100 sites for underground production of aircraft and engines were identified and located. These plants had a total planned manufacturing area of about 12.5 million square feet. By war's end, about 7.2 million square feet had been excavated, and some 11,000 machine tools were in place. It is estimated that, in the summer of 1945, between 35,000 and 40,000 people were employed underground, but the actual output of finished aircraft or engines was very small. The entire effort had been too late to be effective.

There was a striking difference between the underground installations of Japan and those that had been observed in the spring of 1945 in Germany. Nothing like the carefully planned and well-executed installations at Nordhausen or at Nekar-els were found in Japan. The Germans had had plenty of prior experience with underground installations and had planned for their use far in advance. In Japan, dispersal was purely an operation of desperation. Even if they had known as much about underground installations as did the Germans, they made the mistake of waiting too long to begin operations.

Japanese Underground Plants

The typical Japanese underground plant was housed in hastily driven, unventilated, poorly drained tunnels or galleries, hand-hewn into Japanese mountain sides. Natural caves and a few existing mines were used, but most of the excavation was new. Fortunately, much of the terrain of central Japan lends itself well to such operations. In many places the volcanic rock is easily worked with hand tools. Properly designed tunnels of reasonable dimensions may be cut without the need of extensive shoring to keep the overhead in place. Little blasting was necessary. The main requisite appeared to be an army of strong backs and a plentiful supply of picks and shovels.

The labor was done largely by Chinese and Korean prisoners of war. A few private contractors were given some of the jobs but, for the most part, the construction appears to have been handled by the Japanese Army. Battalions of engineers, and even infantry, were moved into mountainous areas and set to digging. Large areas of Honshu and Kyushu were to be honeycombed. A remarkable feature of many of the installations was their inaccessibility. How some of the heavy machinery was transported over roads that were almost impassable to a jeep in good weather is still somewhat of a mystery. Lathes, drill presses, boring machines, and other heavy tools must have been manhandled (*Continued on page 426*)



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Most underground aircraft machine sites were incomplete at the end of World War II. In this aircraft engine factory machine tools were manhandled into the gallery on blocks and rollers when the war collapsed.

▼

America's Changing Food Pattern

Although per Capita Consumption of Food Remains Close to 540 Pounds per Year, Changing Tastes and Economic Factors Modify the Content of America's Food Basket

By Frederic W. Nordsiek

EATING is as pervading and urgent an element in human life as it is in the existence of lower living forms. During most waking hours, the human organism is continually conscious of some sensation connected with food. Even basic human social structures are built around meals. The quantities and kinds of foods consumed by men and women determine not only their physiological well-being and stamina, but also their mental equanimity and morale.

The importance of food to mankind may likewise be measured in terms of the amount of nutrients required to maintain human life. Consumption of less than 500 pounds per year of food, dry basis, means hunger and emaciation for the average individual. Contrariwise, consumption of as much as 600 pounds of solid nutrients, yearly, usually results in obesity. In the United States, certain individuals exceed one or the other of these limits, but the average per capita consumption of food by Americans lies in the middle of this range, and is about 540 pounds yearly. In the past, per capita food intake has dropped during times of economic depression and during wars, but these declines have always been followed by corresponding increases. Hence the secular or long-term trend of total food intake in this country has remained quite level, certainly during the Twentieth Century and, so far as records exist, previous to then. Does this mean that the food pattern of the United States has long remained static? Indeed no, because although total food intake has remained relatively constant, the kinds of food composing this total have changed extensively.

The amount of food consumed by an individual is determined by need, as dictated by body size and physical activity, and the factor of greediness. But individual choice of kinds of food is influenced by a vastly more complex array of factors. Availability and cost are prime influences in food choice, but not limiting ones; for example, wheat has long been cheaper and more plentiful than rice in Japan, yet rice remains the staple Japanese cereal. This illustration points to a third and governing factor in the choice of food, namely, custom. Effects of these three main determinants of food choice are variable, because availability, cost, and custom are not static.

Availability of established foods may increase, as by improvements in production and processing methods; or may decrease, as by crop failures or by augmented tariff barriers raised against imported foods. Essentially new foods occasionally become available, as when tomato juice was "invented." Influencing the choice of foods is the relative cost which alters through changes in prices of foods, and also through shifts in purchasing power of the consumer. Custom is based on a more or less static background determined by national origin, prejudices, concepts of nutritional value (both correct and fallacious) and taboos of religious or sectarian nature. Custom is also subject to change by dynamic influences, such as education, propaganda, and advertising. That the influences toward change in the dietary have been most active in the United States during the Twentieth Century is evidenced by the markedly changed constitution of the American food pattern since the turn of the century.

In its earlier years, the extroverted young United States was too preoccupied with growing to maintain adequate records of such subjective matters as food preferences. Little quantitative information about American food habits prior to 1900 was recorded, and even the qualitative data available are of dubious accuracy. Literary descriptions of the early American dietary by foreign authors do exist, but, like the account given by Dickens in *Martin Chuzzlewit*, these were based on superficial observations made by fast-moving travelers, and were colored by the natural tendency of visitors from older, more cultured countries abroad, to disdain customs of the then upstart United States. But beginning in 1909, the Department of Agriculture of the United States Government has kept and published reliable records of food consumption in this country. The Department of Agriculture is interested in food habits and consumption because most foods are of agricultural origin, so that food use is a fundamental measure of the farmer's welfare.

Same Bulk: Greater Variety

As indicated previously, statistics of the Department of Agriculture show that the secular trend of total per capita food intake has remained essentially level since 1909. Furthermore, these data reveal that, per capita, the average consumption of a few individual foods has also remained virtually unchanged. In this category are eggs, butter, fats, and total meats (although within the meat group a decline in beef has been offset by a rise in the consumption of pork). Foods that have gained in consumption are milk, citrus fruits, tomatoes, leafy green and yellow vegetables, and sugar. Foods that have declined in use since the turn of the century are potatoes, cereal grains, and apples. Certain compensatory relationships may possibly exist among these changes. Increased use of leafy green and yellow vegetables perhaps corresponds to the decline in potato consumption, and greater use of citrus fruits, arising from co-operative merchandising and improved shipping facilities, may compensate for reduced apple usage. To gain some understanding of the reasons underlying marked changes in the use of certain foods, in contrast to the relative stability in consumption of others, let us examine in detail

one food in each category: eggs, whose per capita use is unchanged; milk, whose use has increased; and potatoes, with declining consumption.

The total annual per capita food intake of 540 pounds given above was stated in terms of moisture-free, solid nutrients. But since most foods contain more than 50 per cent moisture — many exceed 90 per cent — the actual food intake is several times 540 pounds. For example, since 1909, egg consumption has been about 32 pounds (exclusive of shells) per capita per year. Since eggs contain approximately 74 per cent water, this weight of egg magma represents only slightly more than eight pounds of water-free nutrients.

Eggs — A Stable Food

Operators of diversified farms usually maintain chicken flocks as sources of eggs for their own tables, and as an occasional supply of meat when a chicken is slaughtered. Eggs thus available often exceed immediate farm needs, and surplus eggs are a readily marketable commodity. Eggs are but slowly perishable, so that when convenient they may easily be brought to town for sale. Some eggs reaching urban tables, and many eggs used in processing, actually originate in this casual manner. Today, however, most eggs for table use come from specialized poultry farms which are usually located near, or even within, urban foci of consumption. Such farms, jocularly called "egg factories," are designed for maximum egg output, with selection, housing, and feeding of the hens aimed toward this objective. By expediting the gathering and marketing, the efficient operation of specialized poultry farms also reduces the interval between the laying and use of the eggs.

A step forward in the distribution of shell eggs was achieved with the establishment of cold-storage facilities for the purpose of delaying spoilage and thus making marketing more flexible. A still more important advance in distribution has been the development of processing of liquid egg. Such processing involves "breaking out" by hand, in which operation yolks are sometimes separated from whites. The liquid egg is then churned, to establish uniformity, and filtered. A little of this liquid egg finds immediate use, more is dehydrated, but the bulk is quick-frozen. Occasionally, liquid egg is first frozen and then dehydrated later, when drying facilities are available. Such processed eggs, particularly those frozen, are used in vast quantities in baked products, such as noodles, and in mayonnaise, and similar foods in which eggs are an ingredient.

Why have not these fundamental advances in egg production, distribution, and processing increased the total use of eggs in the United States? The principal reason why eggs are a stable product is that improvements in production and storage have been concerned mainly with reducing seasonal fluctuations of egg use within a given year, both by diminishing seasonal peaks of production and by deferring consumption of eggs laid during the high-production months. Since egg production is related to the reproductive cycle of the chicken, egg laying is high in the spring with an extreme peak in April, and low in the early winter with a minimum point in November. Under uncontrolled laying conditions, as in the small chicken flock of the diversified farm, such annual fluctuation of egg output is extreme. Seasonal variation is appreciably reduced under the controlled-laying conditions of the specialized poultry farm. The greater proportion of eggs currently produced under controlled-laying conditions is evidenced by a comparison of seasonal fluctuation in egg production of 20 years ago as compared with that of today. On the basis that February laying is represented by an index number of 100, two decades ago production would reach a low of 40 in November and a high of 170 in April, whereas today the range is only from 60 to 150.

Variation in seasonal consumption has been reduced even beyond the lessening of laying fluctuations. Originally, when eggs were plentiful during the springtime glut, they were correspondingly inexpensive, and were consumed in large quantities; conversely, during the winter scarcity, eggs were expensive and fewer were used. But now processors purchase eggs during the glut months, and convert them into dried or frozen form which may be stored indefinitely and used later. Cold storage of shell eggs has also helped defer consumption into months of seasonal scarcity.

It must be acknowledged that eggs are recognized by nutritionists as a valuable protective food, and yield a source of essential proteins, vitamins, and minerals. Nevertheless, they have not enjoyed intensive promotion as a health food such as has been devoted, as will be seen presently, to milk, the equally but no more valuable, food. Therefore, promotion has been a minor factor, at most, in influencing egg consumption.

A final and most potent influence in leveling out the seasonal pattern of egg consumption, and perhaps also in retarding greater total consumption, has been the federal

Photo by Harold M. Lambert

Controlled production and effective methods of preservation have greatly reduced seasonal price fluctuations of eggs. But on a per capita basis current consumption is essentially what it was half a century ago.

government's "Support Buying" program. Started in 1929, this program is carried out to protect egg producers against extreme variations in the price of their product, and consequent hardship when prices may fall below cost of production during the months when eggs are abundant. Support Buying involves purchasing of eggs by the government during times of plenitude, and holding them for release later when eggs are scarcer. Support Buying may hold down total egg consumption by discouraging egg processing. The support program keeps egg prices up during the glut months when processors normally operate their plants; for in order to cover processing costs and still compete with shell eggs, processors must obtain their raw material at low cost.

Therefore, although the seasonal pattern of egg production has been leveled out somewhat, and the seasonal pattern of egg consumption has been leveled still more, total egg use has remained substantially unaltered since 1909. Then, as now, the average American consumes about 300 eggs each year.

Milk — A Growing Food

Numerous factors have favored increasing the use of milk in the United States. Among these are not only improvements in production, processing, and distribution, but also effective advertising and sales promotion, and unparalleled advocacy of milk as a health food by interested dairy groups and by disinterested nutritionists alike. Not least among the reasons for greater use of milk is the bland acceptable nature of milk itself. This makes possible the consumption of milk in large quantities, whether as a beverage, or as an ingredient in prepared dishes in the form of milk products.

On the small farm, milk, like eggs, may be produced primarily for table use by the farm family. But unlike eggs, milk is quickly perishable, so that originally milk available beyond the requirements of the farmer's own family usually had to be discarded. Only with the coming of refrigeration could the farmer chill his milk for holding and subsequent sale. Later, embodiment of refrigeration in automobile tank trucks and railroad tank cars facilitated the flow of milk from the rural milkshed to urban population centers. As with eggs, some milk today is gathered from scattered small farms, but much is produced on specialized dairy farms. The efficiency of these dairy farms has been brought to a high point by progress in animal nutrition and in veterinary medicine, fields of learning that lag little, if at all, behind the corresponding spheres of knowledge applied to human beings.

We have mentioned the use of refrigerated trucks and railroad cars in milk transportation. Supplementing these advances in distribution are many recent improvements in milk pasteurization and bottling. Development of high-speed, mechanical pasteurizing and bottling equipment, of lighter and stronger glass milk bottles, and perfection of the paper, single-use milk container, have all contributed to the increased use of milk as a beverage. Even operations of the route man, who brings milk to the user's door, have been facilitated by improved automotive route trucks.

An essential step in the greater use of milk is perfection of the process of pasteurization. Usually performed just before bottling, pasteurization is the application of heat, sufficient in degree and duration, to kill all disease germs and most other microorganisms, and yet the thermal processing must be sufficiently mild so as not to affect flavor, physical properties, or nutritive values of milk. Pasteurization removes the otherwise ever-present threat of spread of disease by milk. It also markedly delays spoilage.

The advances described have greatly increased the use of fluid milk, but this form alone accounts for only part of the upswing in total milk consumption; the remainder is attributable to concentrated and preserved milks and milk products. Concentrated canned milks are available both as the nonsterile condensed milk that is preserved by a high concentration of sugar, and as the sterilized evaporated milk. Canned milks are widely used in homes, where they supply low cost, nonperishable forms of milk for use in prepared dishes. Dehydrated milks of both whole and skimmed types are widely manufactured, but are used more commercially than domestically. Dried milks are semiperishable products. They require no refrigeration and may be shipped in bulk in ordinary barrels. Cream is frequently preserved by freezing it for later use in the manufacture of ice cream. Finally, a wide variety of cheeses bring milk to the consumer in yet a different form. Preserved milks and milk products are usually made in plants, located near farm sections, operating at peak capacity during the flush months when milk is most plentiful. This method of production, and the ease with which the products may be kept and transported, make concentrated milks and milk products relatively inexpensive. Wide use of milk in these forms is, therefore, favored.

In no small part the increasing use of milk is due to intensive promotion of it as a health food. This program rests on a firm foundation of fact, because milk contains an array of nutritionally essential vitamins, minerals, and proteins of the highest nutritional quality. But, although the gospel of milk's food virtues is true, at least a part of its wide acceptance may be traced to the skillful use of advertising, publicity, and other forms of promotion by large dairy concerns and by associations organized by them. Furthermore, the agricultural bloc, always a powerful factor in government, has been responsible for milk promotion programs carried out by governmental agencies.

The influences described, others not mentioned, and no doubt still others as yet unidentified, have elevated per capita milk consumption in this country from about 150 quarts per year in the first decade of the Twentieth Century to a current figure of more than 250 quarts per year.

Potatoes — A Dwindling Food

The white potato has long figured importantly in the food supplies of most Occidental peoples. Yet this vegetable was unknown in the Eastern Hemisphere until it was brought home by white men who found it under cultivation in South America when the New World was discovered. The cool plateaus of Peru offered ideal growing conditions for potatoes, and the Incas apparently had cultivated this tuber there far back into ancient times. In fact, cultivation of the potato and domestication of the llama, the only beast of burden known in the Americas before the Spaniards brought horses, are considered to be the two major achievements of the Incas.

Potatoes were carried back to Europe by the early Spanish conquerors of South America, but there the tubers remained a curiosity for some time and were seldom

Like bread, milk is a staple product in most meals. As a result of improvements in the processing and distribution of milk, and active promotion of milk as a health beverage, annual milk consumption in the United States during the past four decades has increased from 150 quarts per person to 250 quarts.

Photo by H. Armstrong Roberts

eaten. Early recognition of the economic and food values of the potato resulted in numerous intensive efforts, both on the Continent and in the British Isles, to persuade the people to eat this vegetable. At first such efforts failed everywhere except in Ireland, where potatoes were quickly adopted and soon became the staple crop. Since potatoes are easily grown, detractors then called them "the Irish lazy root." The potato was returned to America from Europe via Bermuda, reaching these shores again in 1621. Potatoes found ready acceptance by the new inhabitants of the hemisphere of their origin, and became a basic food of the United States.

To understand the role of potatoes in the American dietary, we must answer two questions: Why was the potato so readily accepted as a staple food? And why did total use of potatoes later decline sharply? In part, the first question is answered by the ease with which the nutritious roots are cultivated. Since potatoes are easily raised in the climate prevailing in most sections of the United States, they are inexpensive. Potatoes are easily stored between growing seasons. They may be left in the ground for digging, as needed any time, until the ground freezes, or they may be dug and stored in cool root cellars until the next crop is available. Potatoes are likewise readily shipped to market without refrigeration, and may be packed in bags, barrels, or other cheap and plentiful containers. This ease of storing and shipping of potatoes is in strong contrast to similar factors in relation to the succulent vegetables which must be picked at a critical point of maturity, and which wither soon after picking unless special measures are taken.

But the wide use of potatoes goes beyond ease of production, storage, and distribution; in no small measure it depends on the acceptability of the food itself. As has been shown above in discussing milk, bland foods are acceptable to most persons, and are amenable to consumption in large amounts. Consequently, the potential consumption of these roots is enormous. Also, like milk, potatoes can be prepared for the table in many forms of widely differing tastes, textures, and other gustatory characteristics. In view of all these considerations, it is not surprising that the standard American meal calls for meat, vegetable, and potato.

Then why has the use of potatoes declined during the Twentieth Century? The comparative dwindling popularity of this food is partly the result of its replacement by other vegetables. Cultivation of succulent vegetables is most difficult and more exacting than potato growing, but has been perfected by research conducted by seed growers and by agricultural divisions of state and federal governments. But wider use of non-root vegetables has also been aided by advances in processing and distribution, and particularly by refrigeration facilities now available in fast railroad trains, or recently even in airplanes. During the winter, quickly perishable vegetables may be rushed from those sections of the United States where crops grow all year around to other sections, without appreciable loss of flavor or nutrition. Canning and freezing and, to a limited extent, dehydration also make a wide variety of vegetables available everywhere, all the year around, and at relatively low cost. Thus, the housewife may now find any vegetable she wants during any season of the year, if not in the bins of her green grocer, then in cans on the shelves, or frozen in the low-temperature storage cabinets of retail food stores.

Admittedly, these advances still have not reduced the cost of succulent vegetables to the point where they are, in general, as cheap as potatoes. Since 1909, however, there has been a steady increase in average income with a consequent rise in living standards, so that now more housewives are able to purchase the more expensive vegetables if they wish them.

Factors which are less tangible, and therefore more difficult to measure, in the reduced use of potatoes, are the changes in attitude toward foods as a result of education in nutrition. Early nutritionists (*Concluded on page 438*)

Licking the Language Problem

Modern Pedagogy Saves Time and Wins Support of Students Studying Foreign Languages for Pleasure and for Work. New Program Develops Ability to Read Technical Material

By William N. Locke

SCIENCE and technology are often considered to be disciplines of a type so radically different from the arts that there appears to be something contradictory in studying the technical and scientific courses on the one hand, and modern languages on the other.* Some members of the utilitarian school of thought in education even seem to feel that a knowledge of foreign languages, as well as of music and the arts, is but some sort of pseudocultural window dressing. Yet, unless that millennium comes in which English is the truly international vehicle of expression, a knowledge of one or more foreign languages is essential to the man who would be broadly and well educated. It is not possible to overlook the cultural advantages which come from the ability to read and converse in a foreign tongue. Nor are foreign languages less essential to the man who would do advanced and original work in any field of science or in most fields of engineering, and who may regard a knowledge of foreign languages as strictly utilitarian.

The history of teaching foreign languages in the technical colleges, and even in the liberal arts colleges, has been one of gradual decline. In the manner of the liberal arts colleges, the schools of engineering once had an entrance requirement of as much as three years of one, or even two, languages. Within the past two or three decades, however, language requirements in the technical colleges have been gradually whittled away and in some cases have even been eliminated altogether. The curriculum at engineering schools has placed more and more emphasis on the technical side of instruction with a constant diminution of the number of language courses for undergraduates until "only in undergraduate chemical engineering is the study of German often required in engineering schools."** More attention is paid to the study of language in science than in engineering, because so much advanced work in the various sciences has been done abroad. Even in science, however, it is not infrequent that only one year of study of a foreign language is required, and in some cases, departments have been known to require of their students only one semester of language study. If one compares the present time to that of a few decades ago, when languages were required for entrance to college and a good reading knowledge of one or more languages was required for college graduation, it is logical to conclude that the pursuit of foreign languages in technical schools and scientific institutions, at least at the undergraduate level, is tending toward extinction.

The immense value of becoming acquainted with a foreign language is that we are thereby led into a new world of tradition and thought and feeling.
The Task of Social Hygiene
Havelock Ellis

Only Change Is Certain

Yet, it does not necessarily follow that the pattern of the last few decades will continue unchanged indefinitely. Indeed, there is already evidence that technical education in the past has tended to be too specialized and that it has failed to develop to the fullest the broad philosophical understanding and cultural background which are to be expected of the truly educated person.

The concept of the broad and solid foundation is the very basis for the inclusion of languages and other humanities into the finest technical education. Is there not logic in expecting that a person in possession of an excellent technical training should be equally literate in those studies, customs, and manners which universally mark a person of education and culture? It is the difference in breadth which sets apart the trade from the profession. The graduate of the institutions of science or engineering must take his place in society. Indeed, this is a requirement of increasing importance the more our lives depend upon the products, physical as well as intellectual, of science and engineering. The graduate of a technical institute must move at ease among other educated men and women, and the humanities teach him not to fear the knock on the door of the ivory tower.

Aside from these educationally and culturally desirable objectives, however, there are very practical and utilitarian reasons why an acquaintance with at least one foreign language should be part of the intellectual equipment of every educated person. The engineers and scientists themselves have so shrunk the effective size of the world that no large group of persons can any longer remain isolated from the rest of the world's population. When the extent to which engineers and scientists are

* In addition to providing information of more recent developments, this article includes the substance, and is published in place of, the report of the Visiting Committee on the Department of Modern Languages. This Committee met at the Somerset Club in Boston on June 8, 1946. Members for 1945–1946 were: Richard L. Bowditch, '23, chairman, Creighton B. Stanwood, '20, J. Stuart Crandall, '27, Henry G. Doyle, William Emerson, J. D. M. Ford, and Phillips Ketchum. Present at the June 3d meeting at the Somerset Club were Messrs. Bowditch, Ford, and Ketchum, and, as guests of the Committee, also present were President Karl T. Compton, Dean Robert G. Caldwell, and Professor William N. Locke, Head of the Department of Modern Languages.

** Committee on Graduate Study of the Society for the Promotion of Engineering Education, "A Manual of Graduate Study in Engineering," *Journal of Engineering Education*, Vol. 35, No. 10, June, 1945.

After only one semester of study, students of Spanish go into a class where only the foreign language is spoken. By hearing and speaking the foreign language exclusively throughout the class period, and by studying the language with the aid of records, students make unusually rapid progress. Classes are small so that personal instruction is possible. From left to right are: Milton R. Daniels, Jr., '48, Professor Richard F. Koch, Frank X. Zeimetz, '47, Dean H. Weber, '49 (standing), Pekka Ensio, G, and Barron Brainerd, '49.

M.I.T. Photo

responsible for our present mode of living is realized, it is not difficult to believe that the importance to these men of foreign languages (and history might well be included) has sometimes been underestimated. With increased means of communication and travel grows the need for being able to converse with, and understand the culture of, foreign guests in our land, or of our hosts in those lands in which we may be foreigners.

It is perfectly clear that for any traveler to talk intelligently, to understand what he sees and hears in a foreign country, and to be a good emissary of the United States, he must have a great deal of cultural background which will allow him to come into the new situation offered by a foreign civilization with a good deal of tolerance and appreciation. He must have learned that one can never interpret a second civilization exclusively in terms of one's own, and that things which he has always considered as moral and cultural norms may have to be rejected or revised if he is going to make himself acceptable to the society of a foreign country, or if he is going to bring back from that country a true appreciation of its values.

No Traditional Holdover

No, the language requirements for students of science and engineering are no mere holdover of the traditions of a classical education. They are an attempt to inject something humanistic in a course of instruction which is otherwise largely mechanistic. But they are also a recognition of the fact that large bodies of untranslated, and often unabstracted, technical material exist only in several foreign languages. The moment a student begins to do advanced specialized work in any field, he is likely to find that one or more important papers bearing on his subject are unavailable in English. He will have to read technical articles in the original or get someone to translate them for him. The expenses of translation are beyond the means of most individuals. Even aside from the economic considerations, a translation by someone who does not know the technical field thoroughly is likely to be unsatisfactory, no matter how complete the translator's command of the conversational and literary aspects of the foreign language.

Another wholly desirable result of the study of foreign languages is the attention it focuses on the construction of English. This is particularly evident when men are translating into English, as is done extensively in developing an ability to read technical material. It is a common experience to find that even after the meaning of the passage is thoroughly understood, there still remains a considerable problem of finding the right turn or phrase to express the thought in English. This effort is all to the good, as is anything which makes men more objective with regard to their language.

Every language is a beautiful and useful tool to the people who speak it. To reveal the beauty and make possible the use of a few foreign languages to students at M.I.T. is the work of the Department of Modern Languages. To carry out this work, two separate kinds of language instruction are given in addition to informal assistance in the improvement of speech habits, mannerisms, or accent and inflection for those studying other than their native tongue.† Broadly speaking, the first kind of language instruction, which is taken by undergraduates, is comparable to that of the usual undergraduate language courses and aims to offer foreign languages as a medium of cultural education, as well as a tool for the student's professional advancement. The course of graduate instruction, which is new and has been introduced since World War II, is intended to serve solely as a tool

† This Department also conducts special sections of Freshman English for foreign students who have an insufficient knowledge of our language. To them English is taught as a foreign language, using the same methods by which Americans learn French, German, or Spanish.

As a part of the M.I.T. program for developing ability in speaking foreign languages, the Department of Modern Languages has collections of foreign language records for student use. Speech recording equipment is also in constant use by students who aim at proficiency in spoken languages. In his study of Russian, David F. Tuttle, Jr., G, compares recordings of his pronunciation with that of foreign language records. The Institute hopes to add "visible speech" equipment to its facilities in the near future.

M.I.T. Photo

with which the student may further his knowledge in the chosen professional field by acquainting himself with the advanced work done in foreign countries.

Language in a Dual Role

To the undergraduate, the language is presented with a dual aim. It is, of course, a tool for use in his later professional career, but it is also much more. The language is taught so that it gives the student an introduction to a people, to their mode of life, to their ways of thinking. The undergraduate course recognizes that the student may be required to speak the language, transact business, read the literature, and appreciate the literary expression of a genius of a nation other than his own. In the elementary language courses at M.I.T., undergraduates are given a sound foundation on which to build a broad and cultural understanding; in the intermediate courses the student is introduced to some of the outstanding works of literature as well. These undergraduate courses take full cognizance of the fact that, by the time of his graduation, a student should be educated as well as trained. It also recognizes that the difference between professional and vocational training is more than one of degree. The progression of an individual to the status of a professional person carries with it a connotation of culture and background. The initiation into this culture, the formation of this background, are the province of the humanities of which language is an important element. The undergraduate is not yet too specialized in his professional activities. He can well spend time for broadening himself to recognize and understand the economic, social, and cultural problems of his world.

A New Approach for Graduate Students

In the Graduate School, the situation is somewhat different. Advanced students and research men in science and engineering may be expected to possess those educational and cultural requirements enumerated for the undergraduate. They have, however, a considerably greater need to consult important technical publications in languages other than their own. To help them get the essential minimum understanding of foreign languages of importance in their profession, new courses in reading scientific French, German, and Russian have been developed at the Institute. This is a completely new type of course with methods adapted to its specific aim of teaching the individual graduate student in one semester to read technical material in his own field.

All doctoral candidates at M.I.T. are required to "demonstrate to the Department of Modern Languages the ability to read scientific literature in their field of specialization in English and in two other modern languages acceptable to the department in which they are enrolled." Master's degree candidates in some fields are required to have a reading knowledge of one modern foreign language. These requirements are met by the translation, at sight, of a page or two of technical material into clear, idiomatic English. But the great problem in this connection has been to evolve a means for enabling the student to get a sufficient knowledge of the technical foreign language to pass an examination, without taking up a great deal of his valuable time.

Until 1945 students were left to their own devices to prepare for the language examinations. To be sure, they could take one or more of the undergraduate courses, the purpose of which (at the elementary stages) was to give a general view of the language and a foundation on which to build a reading or speaking knowledge of the language. These courses were not specifically designed to prepare for reading scientific material, however. If the graduate student could afford to spend sufficient time to go into the third and fourth semesters of the undergraduate language courses, he would read technical material in the various fields. If, as an under- (*Continued on page 418*)

Organization—A Neglected Science

Application of the Principles of Science to the Organization of Men's Enterprises Is a Fertile, Vast, and Promising Field Awaiting Exploration

By Alvin Brown

IF you ask any business manager what he knows about organization, you will usually find that he knows all about it. If you inquire how he knows about it, you are likely to find that it was born in him. Since this omniscience is common in industry, probably it prevails elsewhere, too.

When I confront you, therefore, with the assertion that organization is a neglected science, I must expect to be put to the proof. It is that proof, rather than the nature of organization itself, which is the subject of this article.

To show that organization, as a science, is neglected, is not my real purpose, however. It is to be hoped that, seeing the neglect, you will decide that it should be repaired. It is my hope that you will decide that organization should be studied; that there is a science to be founded.

There are several ways in which you might challenge this assertion. Even the word, organization, invites some attention, because its different meanings can be misleading. Perhaps you may have to be persuaded that organization is a science. So many people seem to think that organization means imitating others that it will be necessary, further, to show what kind of science it is; that it is deductive, not inductive. It will help to define the scope of the science to point out that, in the manner of its application — its practice — it is also an art. I hope to convince you that organization is important. And, finally, it is my commitment to show that it is neglected. From all of this I hope you will draw the conclusion that organization should be studied.

What Is Organization?

The word, organization, may have a number of meanings. Most of them are entirely valid; but no discussion can be clear if a word is used without certainty of meaning. Let me therefore define the organization of which I speak.

The dictionary gives two definitions: Organization may be the act of arranging or constituting in interdependent parts, each having a special function, act, office, or relation with respect to the whole. Or it may be the state of being so arranged. Both of these meanings have, obviously, a very broad application. The human body is an organization. A body of knowledge may be organized. A school curriculum may be organized. Anything that can be arranged in interdependent parts is capable of organization. As used here, however, organization is that which can be applied to the concerted endeavors of men; it is the organization of the enterprises of men.

An enterprise begins, of course, with a man, or a group of men, who have a purpose. This purpose comes first. To attain this purpose, human endeavor will be necessary. This endeavor will usually exceed the capacity of the author of the enterprise. It will require the concerted endeavor of other men; perhaps of thousands of men.

It is the mission of organization to concert this endeavor. It is the mission of organization to arrange or constitute the endeavor in interdependent parts, each having a special function, act, office, or relation with respect to the whole enterprise. It is its mission, more briefly, to define jobs and the relations between them. Obviously, this arrangement, this definition, is necessary. The parts of an enterprise do not naturally fall into place. The jobs do not generate themselves spontaneously. The members do not assume their relationships instinctively. To perform the whole endeavor that the purpose requires, the individual endeavors must be concerted. Concert must be a purposive act. This is organization.

Even with respect to the enterprises of men, organization is a word with several meanings. Thus, we speak of organizing a corporation when we incorporate it. This is not organization in the sense in which it is here used. It is only the act which gives legal existence. It is only a step on the threshold of organization. Thus, also, one may speak of organizing his work, in the sense of systematizing it. The use is accurate enough. To arrange one's work in its interdependent parts is, indeed, an act of organization; but it is an object of organization different from the concerted endeavor of men. Even to speak of organizing the work of the members of an enterprise may cause misunderstanding unless one is careful. That kind of organization may relate to methods, to processes, to administration. In so far as it does, it means something different from the definition of jobs and the relations between them.

These nice distinctions have been necessary because an indiscriminating use of the word can be very misleading. Thus, it is almost impossible to tell, from the title of a book, or of a college course, whether it deals with organization in the sense used here, or with the arts and processes of administration. Many a man believes he has mastered the subject of organization, whereas he has really been studying administration, and this may be one of the reasons why organization is a neglected science.

There is one more distinction that must be drawn. This distinction was recognized in the dictionary. Organization may be the act of arranging the parts, or it may be the state of being arranged. It may be the process of creating enterprise, or the structure after creation. We are concerned with the process, that is, the dynamic act of concerting endeavor, not the static, resulting concert. Organization is the process; enterprise is the resulting structure.

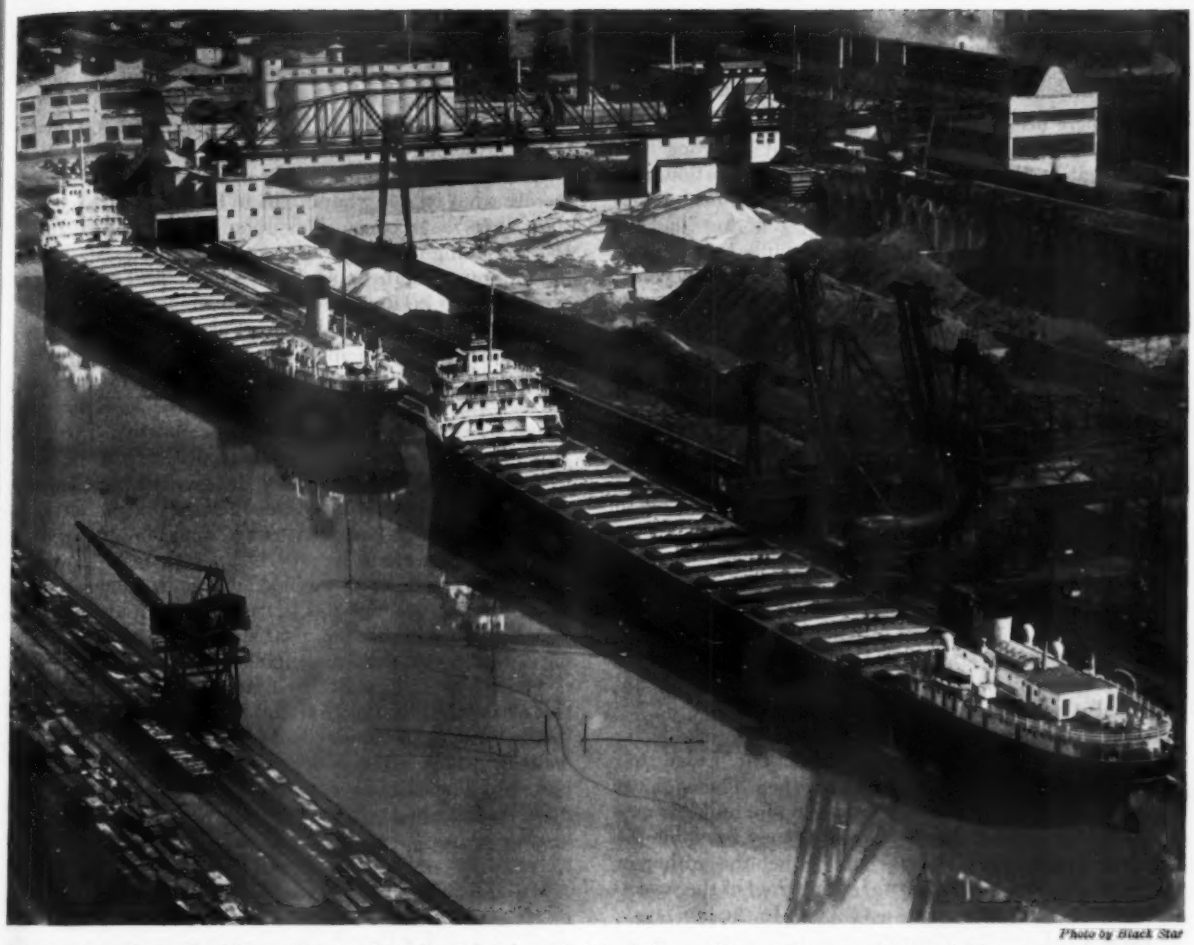


Photo by Black Star

Ore carriers, **Henry Ford II,** *and* **Benson Ford,** *lie at their home dock in the Rouge Plant at Dearborn, Mich., idled by a strike of maritime workers. It is hardly beyond the realm of possibility that such costly stoppages as have been prevalent in the United States since the end of World War II might be greatly minimized, or even averted, when men's enterprises are organized on a truly scientific basis.*

It is not the structure that is a science. It is the process of creating the structure that is a science. For it is a science. Never doubt that. It is a science in the same sense as any field of knowledge.

And yet, is not the meaning of the word stretched? A science is an organized body of knowledge. But the organization of human enterprise has not been organized as a science. It has been neglected. Its principles have not been ascertained and classified. Properly speaking, organization is only an embryo science. Substituting the wish for the fact, however, we may assume that some day it will be formulated and therefore it may be called a science.

It is true that it has not long been regarded as such. Charles DeLano Hine [1] said, as recently as 1912: "Administration as an art is very old. Organization as a science is very new." Indeed, we have a fairly general recognition that there is such a thing as scientific management, but little apparent consciousness of scientific organization. That is why Oliver Sheldon [2] could say: "In industry most managers are confident that, though they may have failings, they certainly do not lie in the field of organization. Consequently industrial organization has suffered either neglect or distortion."

From Boston, one approaches the Institute by a bridge over a wide river, and ventures upon it without fear or qualm, without even a thought of what makes it a bridge. But, of course, bridges are not to be taken for granted. A bridge is the handiwork of man. Even more importantly, it is the mental work of man. A bridge, also, is an organization. It is the result of a conscious process applied to natural things and forces. These inanimate things — these elements of steel and stone — have been arranged by principles. If a bridge requires principle, can anyone believe that human beings can be arranged in an enterprise without the use of principle? Can anyone believe that the principles by which men are arranged can be any less a science than the principles by which stones are arranged? Surely, this is true. There must be principles by which human endeavor can be concerted most effectively. These principles will comprise a science of organization.

The corollary of this conclusion, naturally, is that the principles of organization will not be matters of invention. They will not be chance discoveries. Like the principles of any science, they are to be derived by some

[1] Charles DeLano Hine, *Modern Organization,* (New York: Engineering Magazine Company, 1916 edition), page 55.

[2] Oliver Sheldon, *The Philosophy of Management,* (London: Sir Isaac Pitman, Ltd., 1923), page 102.

rational method. They must be educed, proved, and confirmed. Such is the source of every science.

Organization Is Not an Inductive Science

But where are these principles to be sought? The answer to this question discloses the most grievous mischance that has troubled the science of organization, and the one that has probably contributed the most to its neglect. So many people labor under the notion that the existing structures of enterprise are a guide to organization. It is the case method gone astray. It makes an astonishing assertion. "Existing enterprises," it says, "have such and such a structure; therefore, all enterprise ought to have such and such a structure." It is the fallacy of arguing in a circle; of lifting one by his bootstraps.

Much, too much, that is written and taught about purported organization is of this nature. The authors point to existing structures of organization, and say: "See! That is how you go about organizing." One could as sensibly point to a bridge, and say: "See! There is how you build a bridge." Much more sensibly, indeed, for we may be fairly sure that the bridge has been built by a capable engineer, but we have no assurance that an existing structure of organization has been built by a capable engineer.

Now, a reply to that might well be: "Oh, but the bridge proves it is good by standing. And the enterprise proves that it is good by being successful." It is a plausible answer, but it has two defects.

In the first place, it is not likely that bridges could ever be built by imitation. Conditions differ. The bridge that may serve one need will not serve another. The engineer must return to his principles every time he builds a new bridge, however much the new product may resemble the old. It is impossible to believe that either the author or the engineer could be content to let the proof of the soundness of the structure await its actual use. In the same way, we cannot believe that the author of an enterprise could afford to imitate some other enterprise when his circumstances and his need may be different. Nor can he afford to let the proof of the soundness of his structure await its actual use.

But there is an even greater defect in this answer. It is true enough that, by standing and serving, the bridge is its own proof of the principles that were applied in its building. But does an organizational structure afford the same proof? Let us see.

There are at least four things that will affect the success of an enterprise. Besides organization, there are personnel, administrative method, and external influence. The success or failure of an enterprise is the resultant of these four components. How is one to measure the effect of each of them? If three of them — if perhaps only two of them — are favorable, the enterprise may be successful. It is successful, not because of the other factors, but in spite of them. It would be more successful still if all the factors were favorable.

Business success may be in spite of poor organization; business failure may be in spite of good organization: in either case, by reason of other factors. Nor is success an absolute quantity. Industry does not aim to be merely successful; it aims to be as successful as it can. Permanent success comes only from the highest aim. Not even a successful enterprise can afford to be complacent in the face of the possibility that better organization might yield greater success.

The factors do not have their several, separable effects. They have an aggregate, composite effect in the relative success or failure of the enterprise. None of the factors can be judged, therefore, by its effect. Organization does not present its own proof. It can be appraised only by the test of principle.

Cases can as readily teach error as truth. They tell merely what is; not what ought to be. To generalize upon them is to reach conclusions upon false premises. Inductive reasoning is only as accurate as its material. To say, for example, that many companies "find councils of executives to be useful," is clearly a *non sequitur* in the obvious absence of any standard of usefulness. Rational thinking can say no more than that many companies have councils of executives, and have thus far survived.

Does anyone suppose, either, that the need for clear definition of responsibilities could be concluded by compiling the practices in existing enterprise? Quite the contrary. If one were to judge by the generality of existing enterprise, one would have to conclude that definition is unnecessary, or is necessary only in latent, inferential, hearsay fashion.

The case method, as applied to organization, amounts to a popular vote on what is truth. As to many matters, popular vote will provide a satisfactory answer. In building a bridge, we need an engineer, and a science.

The whole fallacy of the assertion that organization can be devised by the trial and error of businessmen lies in the absence of standards. It lies in the absence of the controls which science demands. It is not a scientific method. The science of organization cannot be built upon such ground.

It Is a Deductive Science

If the principles of organization are not to be decided by the existing structures of enterprise, where, then, shall we look for them? The answer seems plain enough. Organization is required to concert the endeavors of men. It serves to make those endeavors effective. It is, therefore, a means to an end. It is an instrument that serves administration. Like any instrument, it must be adapted to its use. Its nature is to be determined by the nature of its use.

Administration, itself, is a science. It has certain universal requirements. It is in those requirements that the nature of organization is to be sought. Largely, those requirements are self-evident truths. From these the principles of organization may be deduced. Perhaps the most fundamental of these truths is that, presumably, the author of an enterprise desires administration to be as effective as possible. It seems also self-evident that he desires it to be economical. From such truths it is possible to deduce many principles of organization.

It is possible, also, to rationalize the means by which an author enlists additional members in his enterprise, and to deduce therefrom many of the principles which should govern relationships in an enterprise. Even that familiar truth that the sum of the parts is neither more nor less than the whole, however it may be faring in physics, is still valid and useful for organization.

I do not mean that this deductive process is too simple. Compared with many other sciences, however, it is extremely simple. Not to go too far afield, I suggest that, if industry had devoted one-tenth the effort to the study of organization which it has de- (*Continued on page 430*)

THE INSTITUTE GAZETTE

PREPARED IN COLLABORATION WITH THE TECHNOLOGY NEWS SERVICE

Chairman for Physicists

GEORGE R. HARRISON, Dean of Science at M.I.T., has been elected chairman of the American Institute of Physics. Recently reorganized and changed from a loose federation of the leading national societies in the field of physics to a membership organization,* the American Institute of Physics is the organization for this country's professional physicists. It is composed of the American Physical Society, the Optical Society of America, the Acoustical Society of America, the Society of Rheology, the American Association of Physics Teachers, and about 9,000 individual members.

Dr. Harrison served for several years as president of the Optical Society of America, and in addition to his post of Dean of Science at M.I.T. since 1942, is editor of the *Journal of the Optical Society of America*. His election to the new post comes at a time when plans are being formulated for a new journal in the field of physics.

"Physics is progressing so fast today that neither scientist nor layman can keep abreast of all its phases," said Dr. Harrison. "Many new developments of general interest and application are now reported in technical publications familiar only to specialists in a single field.

"There is an urgent need for a new journal of general interest which gleans material from all branches of physics and reports it to all physicists, to other scientists, and to engineers and others interested in physics. It is such a journal which the American Institute of Physics plans to launch within the next few months. The new journal will serve two major purposes. It will foster cooperation among physicists, and strengthen the feeling of unity in a large profession composed of diverse specialists; and it will inform other scientists and laymen of the most important new developments in one of our most fundamental sciences."

The election of Dean Harrison to this important post is a well-deserved honor and recognition of his leadership in the field of physics.

Biology in a Broad Education

THE statement, made by an internationally known physical chemist, "I believe that the next 20 years will be as great years for biology and medicine as the past 20 have been for physics and chemistry" expresses the view held by many scientists who are aware of developments in fields bordering on biology, as well as by the progressive biologists themselves. It is, therefore, satisfying to find that M.I.T. is pioneering in the field of quantitative and applied biology and that it has a young and able staff in its Department of Biology. On the other hand, it is not satisfying to find inadequate quarters provided at a time when the opportunity open to the Department is so great.

At the request of the Visiting Committee on the Department of Biology**, at its meeting on October 7, 1946, the Department presented its plans, curriculum, and administrative organization. The Committee was most favorably impressed with the program as outlined by the Department representatives, and submits the following findings and recommendations:

The personnel of the Department is young, and the Department appears healthy, showing indications of good integration and teamwork. The application of new physical and chemical techniques to the study of cells and tissues is one of the most promising frontiers of biological science. The activities of the present Department in this field are among the most important going on in the country today.

The Department's effectiveness is limited by its available space. The need for the construction of a new building is immediate and serious. Accordingly, the Committee urges action leading to the early provision of adequate quarters. It recommends that preliminary plans for such a building be drawn immediately.

The Department is not sufficiently well known outside of its professional field, and it is recommended that the Administration consider ways and means of presenting the Department properly to potential students, undergraduate and graduate, in such a manner as to bring the unusual qualifications of the Department to the attention of specially interested and able students.

Anyone entering his lifework today should have a fundamental knowledge of the human organism. It is recommended that the Administration consider including biology as one of the required subjects in the first year, not only because of its importance to this Department or because of its increasing significance in industrial technology, but particularly to provide an essential part of a broad education.

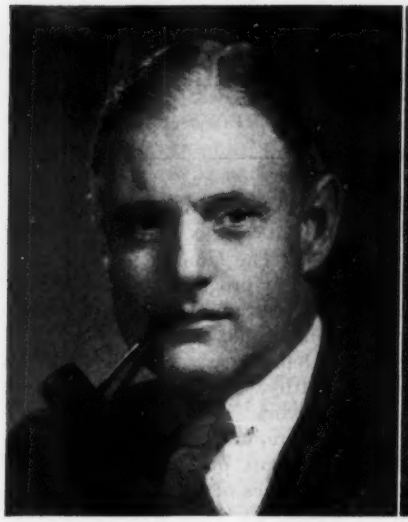
M.I.T. Athletes Do Well

COACHED by Joseph L. Levis, '26, Olympic veteran and formerly national champion in foils, the M.I.T. Fencing Team completed its first season, since its postwar re-establishment, with an undefeated record in its encounters with teams from other colleges in the northeastern part of the country. Harvard and Cornell were the strongest opponents, as the following tabulation of the season's record shows:

M.I.T.	16	Princeton	11
M.I.T.	14	Harvard	13
M.I.T.	14	Cornell	13
M.I.T.	19½	Boston University	7½
M.I.T.	15	Yale	12
M.I.T.	11½	Brown	10½

** Members of this Committee for 1945–1946 were: Raymond Stevens, '17, chairman, William J. Mixter, '02, Edward S. Farrow, '20, George B. Darling, '27, James B. Fisk, '31, Detlev W. Bronk, and A. Baird Hastings.

* As recorded in The Technology Review, April, 1947, page 330.



HERBERT L. BECKWITH, '26
Professor of Architectural Design

SAMUEL H. CALDWELL, '25
Professor of Electrical Engineering

IVAN A. GETTING, '33
Professor of Electrical Engineering

Not to be outdone by the fencers, the newly organized Wrestling Team, under the able coaching and guidance of George Myerson, has been crowned New England champion, after taking first place in the 165-pound, 175-pound, and unlimited classes. The M.I.T. wrestlers scored 24 points to win the first postwar New England Intercollegiate Wrestling Tournament, during which they defeated wrestling teams of Williams, Springfield, Wesleyan, Brown, and Tufts.

The Institute's basketball and swimming teams have won more than half of the events in which they were entered and the Hockey Team finished third in the New England Intercollegiate Hockey League. Thus has been completed one of the most successful winter seasons in the history of M.I.T. sports.

All on an intercollegiate basis, the Institute's sports program now includes basketball, crew, cross country, fencing, golf, hockey, lacrosse, pistol, rifle, soccer, squash, swimming, tennis, track, and wrestling. Since the end of World War II, intercollegiate athletic competition has been resumed in the sports of fencing, hockey, pistol, rifle, and wrestling.

The Forward March

THE largest number of promotions on the M.I.T. faculty for many years was announced by Karl T. Compton, President, recently. Members of the faculty promoted from the rank of associate professor to professor are:

John R. Markham, '18 ..... Department of Aeronautical Engineering

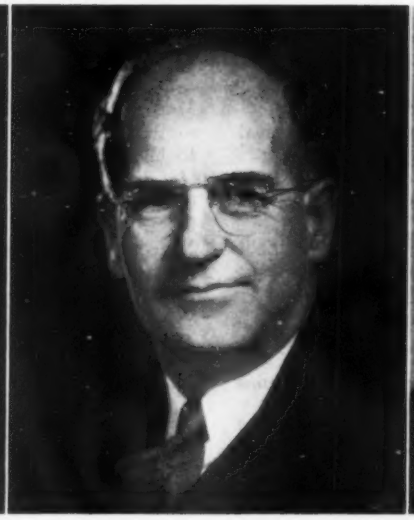
Hsue-Shen Tsien, '36 ..... Department of Aeronautical Engineering

ALBERT G. HILL
Professor of Physics

JAMES HOLT, '19
Professor of Mechanical Engineering

JOHN R. MARKHAM, '18
Professor of Aeronautical Engineering

DEAN PEABODY, JR., '10
Professor of Structural Design



RONALD H. ROBNETT
Professor of Accounting

JOHN T. RULE, '21
Professor of Drawing and Descriptive Geometry

Herbert L. Beckwith, '26	School of Architecture and Planning
Dean Peabody, Jr., '10	Department of Building Engineering and Construction
Ronald H. Robnett	Department of Business Engineering and Administration
Paul A. Samuelson	Department of Economics and Social Science
Samuel H. Caldwell, '25	Department of Electrical Engineering
Ivan A. Getting, '33	Department of Electrical Engineering
Arthur R. von Hippel	Department of Electrical Engineering
John T. Rule, '21	Section of Graphics
James Holt, '19	Department of Mechanical Engineering
Albert G. Hill	Department of Physics

Members of the faculty who were promoted from the rank of assistant professor to associate professor are:

René H. Miller	Department of Aeronautical Engineering
William H. Brown, '33	School of Architecture and Planning
Roland B. Greeley	School of Architecture and Planning
David F. Waugh	Department of Biology
John W. Irvine, Jr., '39	Department of Chemistry
Richard C. Lord, Jr.	Department of Chemistry
Clark C. Stephenson	Department of Chemistry
Herman J. Shea, '33	Department of Civil and Sanitary Engineering
Jerome B. Wiesner	Department of Electrical Engineering
Karl W. Deutsch	Department of English and History

PAUL A. SAMUELSON
Professor of Economics

HSUE-SHEN TSIEN, '36
Professor of Aeronautical Engineering

ARTHUR R. VON HIPPEL
Professor of Electrical Engineering

John B. Rae	Department of English and History
Cecil G. Dunn, '30	Department of Food Technology
Walter L. Whitehead, '13	Department of Geology
Ascher H. Shapiro, '38	Department of Mechanical Engineering
Herman Feshbach, '42	Department of Physics
Clark Goodman, '40	Department of Physics

Cecil E. Hall of the Department of Biology has been promoted from the rank of research associate to associate professor.

Promoted to the rank of assistant professor are:

Burnham Kelly, '41	School of Architecture and Planning, and the Bemis Foundation
Lloyd Rodwin	School of Architecture and Planning
John A. Beckett	Department of Business and EngineeringAdministration
William Van Alan Clark, Jr., '42	Department of Business and EngineeringAdministration
David P. Herron, '41	Director, Parlin Station, School of Chemical Engineering Practice
Jack B. Pohlenz, 6–45	Director, Bangor Station, School of Chemical Engineering Practice
Keith E. Rumbel, '43	Director, Buffalo Station, School of Chemical Engineering Practice
John D. Roberts	Department of Chemistry
Myle J. Holley, Jr., '39	Department of Civil and Sanitary Engineering
Ariel A. Thomas, '36	Department of Civil and Sanitary Engineering
Alexander Bavelas	Department of Economics and Social Science
Marcy Eager	Department of Electrical Engineering
Roberto M. Fano, '41	Department of Electrical Engineering
James N. Thurston, '43	Department of Electrical Engineering
Stephen H. Crandall, 2–46	Department of Mechanical Engineering
Rogers B. Finch, '41	Department of Mechanical Engineering
Fritjof A. Raven	Department of Modern Languages
Bernard T. Feld	Department of Physics

Members of the staff promoted to the rank of instructor are:

Holt Ashley	Department of Aeronautical Engineering
Carroll J. Brown, 9–46	Department of Business and EngineeringAdministration
Leo B. Moore, '37	Department of Business and EngineeringAdministration
Charles G. Swain	Department of Chemistry
Melvin A. Biggs	Department of Civil and Sanitary Engineering
Elery F. Buckley	Department of Electrical Engineering
Wen Tsing Chow, '42	Department of Electrical Engineering
David E. Higginbotham	Department of Electrical Engineering
James K. Hunton	Department of Electrical Engineering
Earl W. Keller, 10–44	Department of Electrical Engineering
Morton Loewenthal	Department of Electrical Engineering
Richard F. Markel	Department of Electrical Engineering
Clarence W. Schultz, 10–44	Department of Electrical Engineering
Malcolm F. Thompson	Department of Electrical Engineering
Albert B. Van Rennes, 10–44	Department of Electrical Engineering
Alden L. Winn	Department of Electrical Engineering
Frederick S. Holt	Department of Mathematics
John B. Kelly	Department of Mathematics
George L. Nelson, '43	Department of Mechanical Engineering
James B. Reswick, '43	Department of Mechanical Engineering
Abdul J. Abdullah, 6–46	Department of Meteorology
John C. Johnson, 6–46	Department of Meteorology

Your Health!

MEETING for the first time in its new location, 96 members and guests attended the 255th meeting of the Alumni Council in the Campus Room of the Graduate House on Monday, March 31. At the conclusion of the dinner, an excellent meal, auguring well for the Council's new meeting place, President Bugbee called the meeting to order at 7:00 P.M. Guests introduced at the meeting were Jose C. Bertino, '23, formerly a commander in the Argentine Navy, and Edward M. Peacock, a graduate student in Business and Engineering Administration.

Reporting for Alumni Secretary Charles E Locke, '96, who was confined to the Infirmary for a few days, Ralph T. Jope, '28, gave an account of activities of the Alumni Office since the January meeting. The treasurer's report showed a favorable gain, although current figures were not comparable with those of former years because of changes in certain of the activities of the Association.

Reporting on the Alumni Fund, Henry B. Kane, '24, announced that the seventh year of the annual Alumni Fund had been completed with 10,003 Alumni contributing a total sum of $184,846.71. The year's average contribution, amounting to $18.48, has risen by $2.00 over the corresponding figure of a year ago. This year's figure is almost identical with that for last year in number of contributors, but the total contributions are up nearly $20,000 or 12 per cent.

President Bugbee next introduced James Lee Phillips, '47, student assistant in the Dean's Office, who spoke on present-day problems of fraternity life at M.I.T. Housing shortages and the financial matters attendant upon increasing living costs are problems which the fraternities, as well as the rest of us, are facing. Although fraternity finances are being well managed, some of the houses have 50 or 60 residents, in spite of normally accommodating only 20 to 25 students. Especially among students whose studies have been interrupted by the war, efforts are also being made to interest more fraternity men to take part in extracurricular activities.

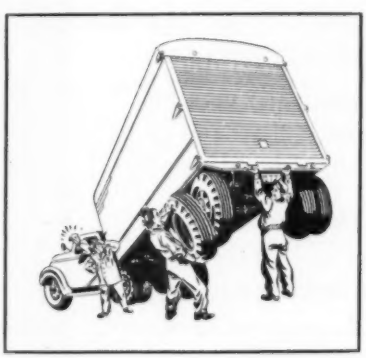
(*Concluded on page 418*)

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Nearly a year ago a Revere advertisement dramatized the remarkable lightness of truck bodies made of magnesium alloys by use of a whimsical illustration of a husky chap lifting the rear of a truck while another changed a tire. We at Revere and many other people were amused by what everybody thought was an amusing, but impossibly exaggerated drawing.

However, it was not so exaggerated as we thought. Recently a company making truck bodies of Revere magnesium reported an accident to a truck operated by one of its customers. This is what happened, in the words of the body-builder's letter:



"The truck, fully loaded with bread, was hit by another vehicle and knocked down a ten-foot embankment. The truck turned over on its side prior to hitting the bottom of the embankment.

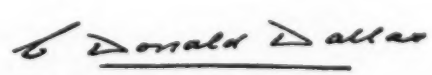
"Five men righted the fully-loaded truck without using any mechanical devices or levers. Examination of the truck after it was righted revealed only very minor damage to the body structure. The principal damage was scraping of paint and one partially dented side door panel. The truck was returned to service immediately, without repairs.

"After one week of service in this condition, the body was returned to our factory for repairs. Total repair charges were only seven dollars.

"We feel that this example of rugged construction of magnesium bodies and their ability to take severe punishment would be of interest to you."

Revere is indeed interested in this new proof of magnesium's strength, but I find still more significant the fact that five men were able to right that truck. Evidently our whimsical drawing was not so impossible as we thought. Here is a case in which imagination came close to prediction.

Imagination is precious. As this incident illustrates, the "wild" idea of today may turn into an advantageous reality tomorrow. Revere has no monopoly on imagination; every worthwhile company uses it to think of new ways to do old things, or new things to do. So I suggest that no matter what you make, nor from whom you buy materials and parts, you keep an open mind toward suppliers, salesmen, inventors, and your own employees. A good idea can come from almost any source, and may make possible better products at lower costs.



Chairman of the Board
REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
Executive Offices:
230 Park Avenue, New York 17, N. Y.

RESEARCH *One hundred miles high*

ON the New Mexico desert below the lava-black San Andreas range, men hasten away from the sleek white body of the rocket and crowd behind the ten-foot-thick walls of a block-house. A red flash from a Very pistol signals two minutes to go. The control operator pushes a button, lighting the igniter. Another button, and the rocket, rising on a column of flame, is thrust skyward on its hundred-mile ride into the heavens . . .

As part of the V-2 research which Army Ordnance is conducting at White Sands, General Electric has been asked to assume responsibility for many of the technical problems of the launchings. The Army needs to know, for instance, what the trajectory of the missiles will be, and how it can be expected to behave. A G-E "differential analyzer," capable of automatically making computations that would require a mathematician weeks of work, figures out these details.

Another problem is to determine what happens to the rocket as it sails into the ionosphere. A newly developed G-E electronic "telemetering" device radios a scientific description of the flight, sending out information about the rocket's acceleration, its temperature, and the position of its control vanes, all of which is picked up by automatic recorders on the ground.

And finally, there has been a problem of reducing the number of costly and time-consuming launchings. General Electric has undertaken development of a "flight simulator," by which information that could be determined in the past only by actual launchings may now be found out in the laboratory.

Thus American Scientists learn about the V-2 —how to defend ourselves against it; how, if need be, to build a better one.

GENERAL ELECTRIC

To Technology Men in the AUTOMOTIVE INDUSTRY . .

• *Do you like spilled gasoline?*

Seems strange that such a simple operation in automobile servicing — the filling of the gasoline tank — should be the cause of so much loss in product, time, and temper.

I believe that a well-designed gasoline tank should include the following:

1 The ability to take gas at the full pumping speed of the modern commercial pump — substantially 15 gallons a minute — without blow-back.

2 Some positive means by which the attendant knows when to stop filling.

3 An expansion zone, automatically provided within the tank, to eliminate spillage caused by temperature changes.

4 A filler-neck which rather than splashing gas into the top of the tank, will discharge near the bottom, thus eliminating evaporation during filling.

VENTALARM* advertisements in Technology Review have brought us many letters from Tech men dissatisfied with the way their gasoline tanks now fill. A car-owner needs only to realize how unnecessary is the inconvenience and hazard of spilled gasoline, to insist on fast-filling, non-spilling gasoline tanks. And that means tanks equipped with the VENTALARM tank fill signal.

Any Tech man who would like VENTALARM for his own gasoline tank, or who desires to examine its simplicity of construction, is welcome to one with my compliments. (There is an installation expense in equipping old tanks.)

Incidentally, we will be happy to receive any comments you may have on gasoline tank filling.

Yours, for fast-filling, non-spilling gasoline tanks,

Frank P Scully

M.I.T. '15

P. S. The VENTALARM whistling tank fill signal has been installed on over a million household fuel tanks. Driver never enters home.

Fifteen different makes of automotive equipment now include VENTALARM as standard factory equipment.

*T. M. REG. U. S. PAT. OFF.

SCULLY SIGNAL COMPANY · 88 FIRST STREET, CAMBRIDGE 41, MASS.

THE INSTITUTE GAZETTE

(*Concluded from page 414*)

Speaking for the Administration, Dr. James R. Killian, Jr., '26, announced that the development of adequate facilities for student housing and recreation was among the top priorities of the Administration and that land west of Massachusetts Avenue was being held in reserve for the development of a center for student housing and recreation. As an immediate step to improve the lot of present students, Dr. Killian stated that Pritchett Hall in Walker Memorial, where the Council formerly met, was being converted into a student lounge. Dr. Killian also announced that President Compton, now visiting alumni clubs in Honolulu and the United States, expected to be back in Cambridge in time to attend the next Council meeting.

Dr. Dana L. Farnsworth, medical director, was then called upon by President Bugbee, to speak on the work of the M.I.T. Medical Department. Comparing modern activities with those of 1913–1914 when Medical Director Dr. John A. Rockwell, '96, reported that 533 consultations were held with 244 students, Dr. Farnsworth stated that last year 32,955 individual calls were made upon the Infirmary for medical aid by students and staff of the Institute. Throughout, the aim of the Medical Department is to prevent disease and illness wherever possible and maintain healthy living, rather than to correct matters after illness has set in. At the same time, every effort is made to carry out the Department's policy of providing full medical services for those at M.I.T. To carry out this policy the present medical staff includes three surgeons under the direction of Dr. John W. Chamberlain, '28, four doctors as internes, and specialists in practically every field of medicine are available for consultation on any type of problem which might arise. The Infirmary has beds for 33 persons at the very modest rate of $1.00 per day in wards, and $2.00 per day in private rooms. Although now equipped with splendid laboratories, x-ray equipment, and dental and eye clinics, Dr. Farnsworth said that one of the pressing problems of the Infirmary was for more space to accommodate the increasing use of the Infirmary by the enlarged staff and student body. He commented that present facilities were inadequate to handle contagious diseases and that all cases of this sort which arose were sent to the contagious hospitals in Greater Boston for confinement at a cost to the student far in excess of the prevailing rate at M.I.T. It is planned that the work of the Medical Department will be reported in considerably greater detail in the June issue of The Review.

LANGUAGE PROBLEM

(*Continued from page 407*)

graduate or high school student, he were fortunate enough to have studied some German, and possibly French, then by some careful reading of technical literature, he could prepare himself for the language requirement without taking further courses. Some men with no previous knowledge of the languages they needed even prepared themselves entirely alone, without the help of any courses, and possibly assisted only by a roommate or friend. It was said that the average amount of time needed to prepare a man through self-study was 250 hours. Thus, the lack of any effective assistance to graduate students in preparing for the reading requirement made it a much more difficult hurdle than it needed to be.

At other technical and scientific schools throughout the country, the problem has been similar. Although there have been some attempts to help graduate students to meet the language requirement, this has generally been accomplished by an extension of the methods already enumerated, and perhaps by having a member of the staff sit down with a few students to read foreign language material with them. The problem has been further complicated by the fact that the men were required to be able to read the literary, as well as the scientific, language, or even instead of the scientific language. It is obvious that there are large differences of construction and vocabulary between these two types of language.

The Promise of a New Approach

At the present time, the graduate student at M.I.T. is required to read only technical material in his own field. Under the new requirements the relative simplicity of the problem made it seem that some simple and direct solution should be possible, and that by the use of experienced teachers the waste motion inevitable in self-study could be avoided, and the time required to fulfill language requirements could be held to a minimum.

In the summer of 1945, the Department of Modern Languages presented to the Graduate School Committee at the Institute a plan for setting up graduate courses in German, French, and Russian. These courses would be open only to graduate students and they were to be only one semester long. They would dispense with the formal study of grammar and would make no attempt to teach the men to speak or to understand the spoken language, but they would concentrate solely on reading technical material in the student's professional field. The question immediately posed for solution was how to instruct, in a single course, graduate students from 10 or 20 different professional fields. The answer was that all the men would meet together once a week for discussion of linguistic peculiarities common to all fields, such as case formation, verb tenses, and sentence structure; then the representatives of each different field were to have separate section meetings twice a week where they would read technical articles.

This treatment of language, purely as a tool, has been criticized at the Institute and outside. It is true that modern languages are spoken languages, and that they are reduced to dead languages by neglecting to converse in them. It is also true that language can be an introduction to the civilization of a foreign country, leading to a better understanding of the world and ourselves. Yet what graduate students in science and engineering specifically need is a tool, a key to unlock the door to the scientific literature in a foreign language. To give them this key as quickly and efficiently as possible was the purpose of these new courses.

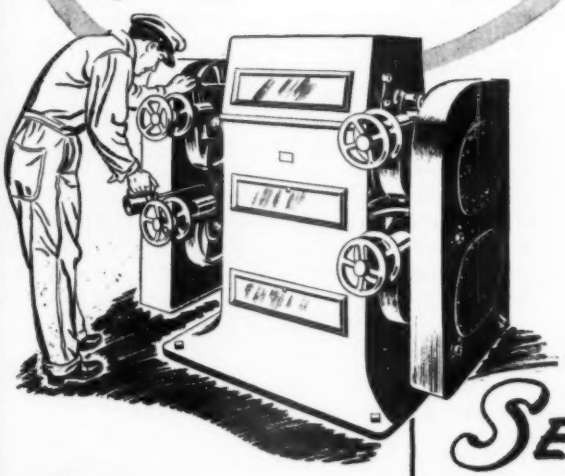
The first course was in German and was offered in the fall of 1945. Many of the students, and even some of the instructors, had doubts that it would really be possible to accomplish enough to get men ready for the reading

(*Continued on page 420*)

THE MARCH OF SCIENCE

UNLOCKING SECRETS OF THE SOY BEAN..

THE SOY BEAN, ONCE PLANTED ONLY AS A ROTATION CROP, WAS PLOWED UNDER TO INCREASE THE FERTILITY OF THE SOIL.



THEN SCIENCE DISCOVERED THAT SOY BEAN FLOUR IS WHOLESOME ...THE OIL MAKES GOOD PAINTS AND SALAD DRESSING...THE MEAL IS GOOD CATTLE FEED... THE FIBRE MAKES PLASTICS.. BUT FIRST EXTRACTION METHODS DIDN'T GET ALL THE OIL...ONLY PARTIALLY SEPARATED THE OTHER INGREDIENTS.

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LANGUAGE PROBLEM

(*Continued from page 418*)

requirement examination in one semester. Sixty-six men took the course. By the end of the first month, those who had had considerable German previously were doing very well, but those with no previous study were discouraged; the intricacy of German thought patterns was overwhelming. A fourth hour per week, on an entirely optional basis, was added, during which beginners (and any others who felt particularly weak) were able to bring up problems, no matter how small, and get them thrashed out in a way which was impossible in the large group where the situation was likely to be to some extent dominated by the majority who had some previous training in German. In the middle of December, the men with the poor background in German, or none, suddenly found that the new course was beginning to be effective. From then on it was obvious that the experiment was going to work and at the end of the semester 62 out of 66 men in the course passed the reading requirement. All but one who had ever had any previous German passed, and of 16 with none, all but three passed. The aim of the course had been achieved. It was possible to teach the reading of technical German in one semester. But another hurdle lay ahead. Could the same thing be done in Russian?

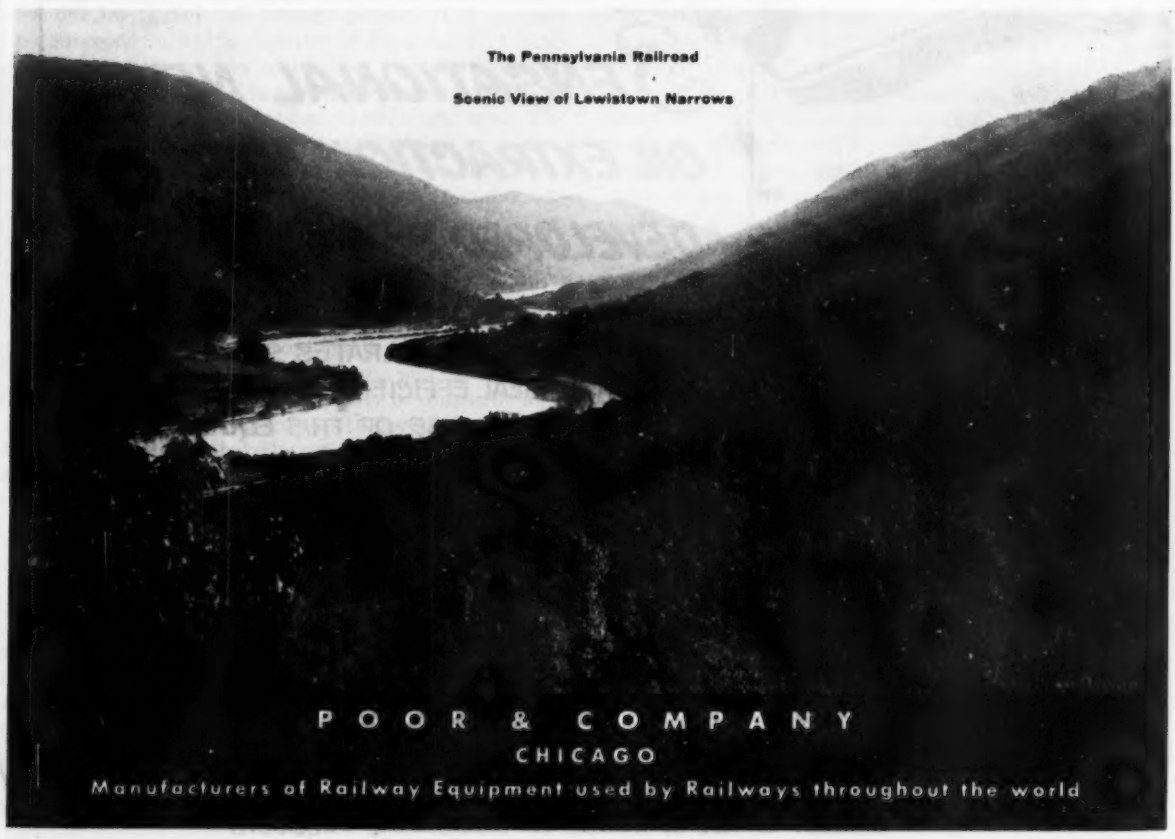
Thirty-six hardy souls started to take the course in Russian in the spring of 1946, many feeling that they were doing it against their better judgment. Several were members of the Institute staff who were taking the language merely for their own satisfaction. At the end of the semester, 23 men took the reading requirement examination; 16 passed. Even some of those who failed expressed satisfaction at the amount of progress that they had made in the course. The feeling of those who had studied French or German previously seemed to be that, except for the alphabet, scientific Russian is not any harder than scientific German. This should encourage others to attempt Russian, since there is no doubt that in many fields the Russians are now publishing scientific material of great importance. This is particularly true in the chemical engineering field in which doctoral candidates are now being advised to take German and Russian instead of German and French.

Accomplishment

In the same type course given in French in the summer of 1946, of 74 men enrolled, 65 took the examination, and 64 passed. These results seem to prove what everyone always suspected, that as French gets more technical, it gets more like English and therefore easier; whereas German becomes harder the more technical it is. Fortunately, in technical Russian, a large number of words are borrowed from German and French so that Russian, too, is easier in technical than in literary works.

The German course was offered again in the fall of 1946 and the increased number of graduate students at the Institute, plus enthusiastic reports on the part of men who had taken the various courses earlier, brought 143 men to the first meeting. Among those enrolled were several from Harvard under the reciprocal plan whereby graduate courses in each institution are open to students of the other. The reading requirement examination was taken

(*Continued on page 422*)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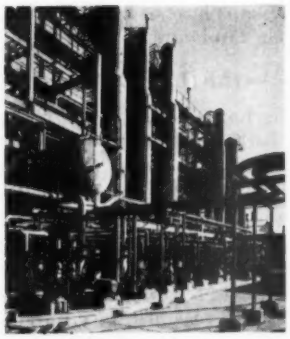

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LANGUAGE PROBLEM

(*Continued from page 420*)

by 139; 132 passed. The reduction in the percentage failing from six per cent in 1945 to five per cent in 1946 is so small that one could hardly claim any improvement in teaching techniques. However, an increased number of favorable comments on the part of the students, both during the course and after the examination, shows that the course was more effective the second time than the first.

We mention comments from students because never in the experience of men in the Department of Modern Languages at M.I.T. have so many students come in voluntarily to tell how much they enjoyed a course and how much they felt they were getting out of it. One man said he enjoyed the German course more than any other he was taking at the Institute. It must be that the men feel that here is a course which sets out to do something and does it, with constant attention to the purpose and eliminating all extraneous material. The average amount of time spent per man seems now to be about 175 hours, as opposed to the earlier 250 hours.

Sequence — the Only Editing

The choice of reading matter used in the reading sections of the courses is perhaps of interest. No textbooks, specialized according to fields of study, are available except in German for chemistry. Even many of these are not satisfactory because the material in them has been edited and simplified. At the Institute, the material used is chosen from foreign books or periodicals, the only editing being the arranging of selections so that the easier ones (that is, those most like English in vocabulary and syntax), are read first. There is no simplification of the original text and nothing is translated from English into the foreign tongue to be retranslated back by the students. All the work is on a mature level, and the later selections in the course represent some of the more advanced work done in the foreign country. Some of it opens up new fields to the graduate students and one doctoral thesis now being written at the Institute is a direct outgrowth of work read by the student in the Aeronautical Engineering section of the German course. Suggestions for the choice of reading material often come from the students, or their own departments, as well as from instructors in language who are constantly on the lookout for new material.

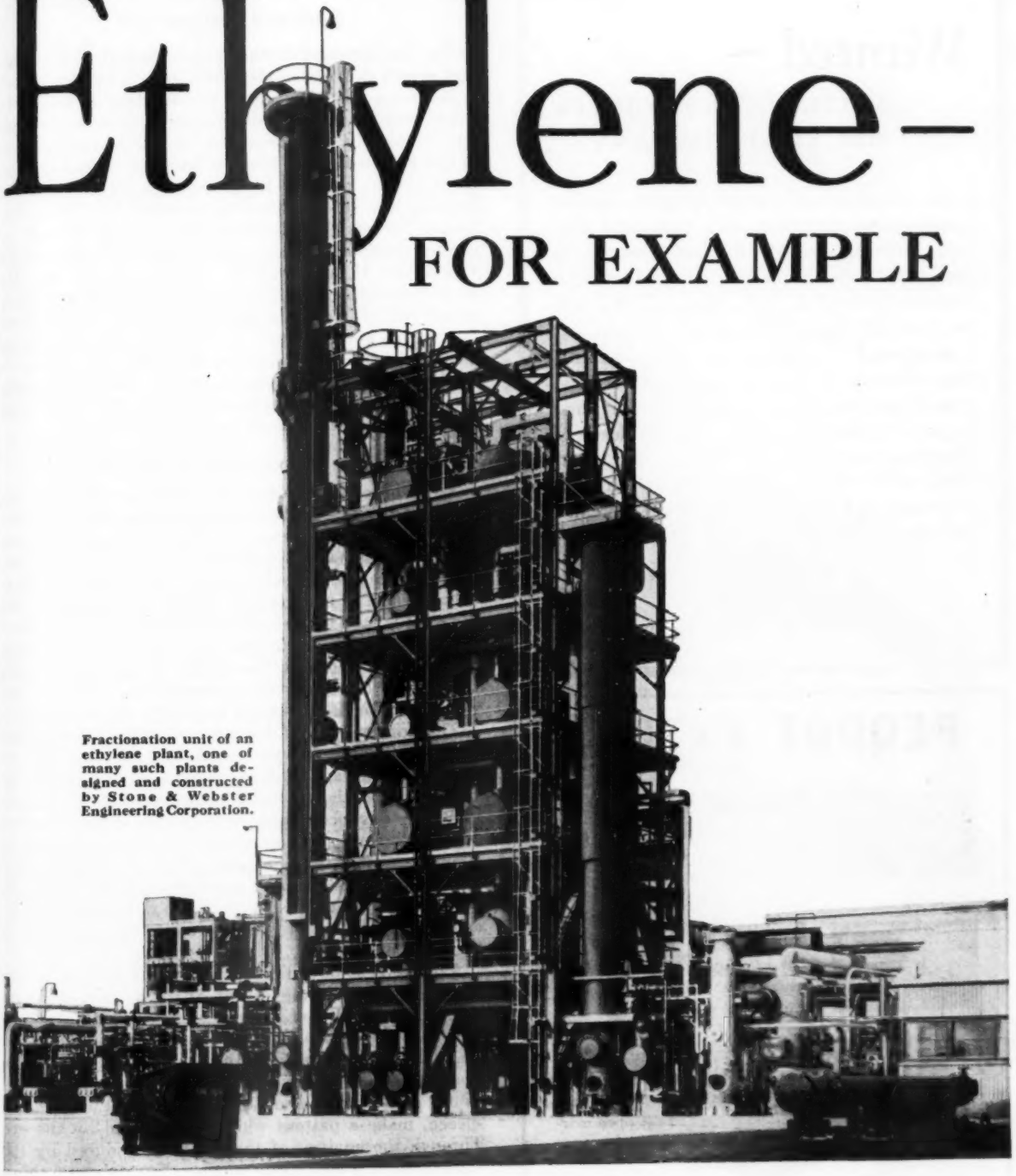
These graduate language courses are tool courses, leaving the cultural values of language study entirely to one side. However, there has been a real need for a practical approach to the language problem of the graduate student in science and engineering. The one-semester scientific reading courses at M.I.T. help him get the reading knowledge he needs in a minimum of time and with the least possible waste motion.

A department at M.I.T. would hardly be complete without a program of research. In the Department of Modern Languages, at the moment, this takes the form of an investigation into the capabilities of new teaching devices. A program is under way jointly with the Departments of Electrical Engineering, English, and Physics to determine the extent to which recordings of students' voices, at various stages of their progress, can help them

(*Continued on page 424*)

Ethylene—

FOR EXAMPLE



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LANGUAGE PROBLEM

(*Continued from page 422*)

in the development of the sounds, accents, intonation, and speech delivery in their own or in a foreign tongue. A recording studio is under construction and is to be ready sometime in the fall. Experiments already carried out in specially soundproofed rooms at the headquarters of the Department of Modern Languages show that recordings are likely to be of considerable assistance in learning how to speak and to understand a foreign language. Various sets of commercial language records, including those produced by the United States Army during World War II, are available for the students' use. The novel part of this program, however, is that these are supplemented by recording equipment which records both the original and the student's imitation of it. By playing back and listening to his own recording, the student is able to make an objective comparison, which is normally completely impossible because bone conductivity keeps us from hearing our speech as it sounds to others.

For Improvement of Speech

Two kinds of recording equipment are used for this purpose: a Sound Scriber, designed as an office dictating machine, which uses inexpensive Vinylite discs; and a wire recorder which has sufficient wire for an hour of recording and which can be played over and over again as often as one wishes. The wire recorder has the disadvantage that the records cannot be stored conveniently for purposes of future comparison, although this is possible by dubbing onto a standard record. The fidelity of reproduction with the wire recorder, however, is excellent so that it is very well suited for detailed work in a study of consonants.

The combination of language records and recording equipment has been very popular at the Institute. So many students and staff members have wanted to use these facilities that it has been necessary to have them sign up in advance to reserve the rooms at busy times of day. Oddly enough, the majority of users are not taking language courses but are attempting to improve their ability to understand and speak Spanish or one of the other modern languages for their own satisfaction. All are enthusiastic and seem really to enjoy this approach to language.

Another type of equipment which will soon be available to students of language at M.I.T. is that being developed at the Bell Laboratories incorporating a principle known as "visible speech." In this equipment, speech sounds are broken up into their components at various frequencies. The relative intensities of these components, as one goes from one sound to another in the stream of speech, make a pattern which can be read by the eye. Through the analysis of the patterns produced by this equipment, it is hoped that we may discover many things which until now have remained obscure about the nature of connected speech.

Perhaps the best way to summarize the work in modern languages at the Institute is to say that the cultural and the practical values are recognized and to each is allotted its particular place. They are in no sense contradictory. They supplement each other. What is practical for one may be cultural for the other, and vice versa. For the undergraduate, a foundation is laid which he may ex-

(*Concluded on page 426*)

More Telephone Service for more people

From the 1946 Annual Report of the American Telephone and Telegraph Company

1 In NO YEAR since the telephone was invented was there such a remarkable increase in the amount of telephone service furnished to the American people as in 1946. The net gain in the number of Bell telephones was 3,264,000, or more than twice the gain for any previous year. Additional telephones were installed at a rate averaging more than 25 a minute every working day.

2 Achievement of this kind reflects the skill, energy and determination of the 617,000 people working together on the Bell System team. What has been done has not been done easily. Many thousands of new employees have been trained in telephone work. It has been necessary to overcome serious difficulties caused by the persistent scarcity of certain essential raw materials needed in large quantities.

3 Most of those who were waiting for Bell telephone service at the start of 1946 had been cared for by the year's end. In addition, the System was able to take care of more than 70 per cent of all new applications received. Yet the total number of new requests for service was so great (there were more than five million) that at the beginning of 1947 there were still about two million people waiting for service.

4 We are working hard to remedy this situation and also to reach the point where all calls can be handled with pre-war speed or better—in short, to give every customer the kind of service he wants when and as he wants it. With experience at hand in abundance, and with new tools and techniques, the Bell System looks forward to steadily increasing achievement in service to the American people.

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LANGUAGE PROBLEM

(*Concluded from page 424*)

ploit later in whatever direction his tastes may lie, and if he wishes, the Department is ready to advise and direct him in his explorations. For the graduate student, a research tool is developed. In both of these lines, aims and methods are flexible, conforming to new requirements, seeking better ways and new aids to more efficient teaching.

NIPPONESE NIGHTMARE

(*Continued from page 400*)

by main strength and awkwardness over loose planks and rollers as the Pyramids of Egypt were built. Even after the installation of the machinery, the problem of getting materials into such plants and of taking the finished products away, was one that would have made an American plant manager's hair stand on end. There is little doubt that had such rabbit-warren plants succeeded in getting into production, their operating efficiency would have been extremely low.

The long, sad story of the Japanese underground movement will be published eventually in the reports of the Survey. Enough has been said in the preceding paragraphs, however, to show what mistakes were made, and to indicate some of the pitfalls that may be encountered if we are ever faced with the necessity of putting our key industries underground.

There is a good deal of talk these days about push-button and atomic warfare. Most of it is premature. Much of it still lies well in the realm of speculation. One thing is certain, however. If such war does come, it will come with little warning, and only those countries that are prepared to meet it will stand a chance of survival.

This article does not predict any such attack against industry in the United States in the immediate future. There is still a little time. The United States, with all the evidence of the past mistakes of others at its disposal, should draw what lessons it may from the debacle in Japan. We should never permit ourselves to be caught up in a panic type of industrial dispersal if we value our nation's existence. There is no need at the moment to put our key industries underground, but we must lay adequate plans for that eventuality and should develop, with the least possible delay, a certain amount of experience so that we will know how and where to proceed when the emergency comes upon us. It would make good sense at this stage to spend a little time and money to find out what the critical problems really are. We have solutions to some of them readily at hand. There is nothing particularly difficult about heating, lighting, or ventilating the so-called black-out type of industrial plant. Such techniques were well developed during World War II. Add, however, the problem of maintenance of such plants and equipment in remote areas under emergency conditions. Add the problem of housing and feeding thousands of workers underground. Add the problem of transportation (underground, on the surface, or by air) under conditions of actual attack. With little effort, a dozen such questions, at present unanswered, will come to mind. Yet, if we do not know the answers to these questions when the time comes, it will be too late.

(*Concluded on page 428*)

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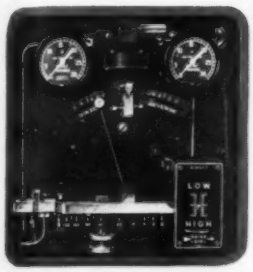
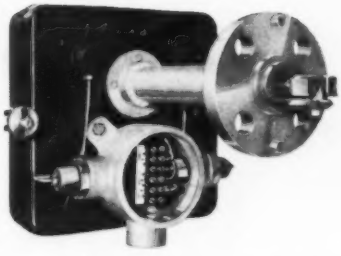
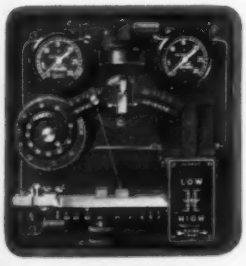


12600 Proportional Controller

12600 Exterior View

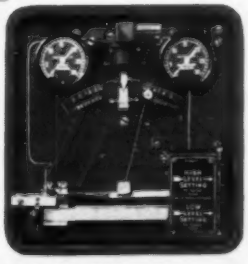


12000-15 Rear View showing Explosion-proof Switch (open)

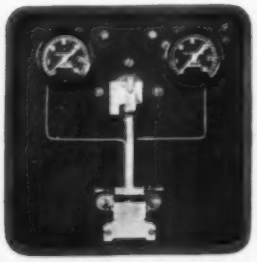


12610 Proportional-Reset Controller

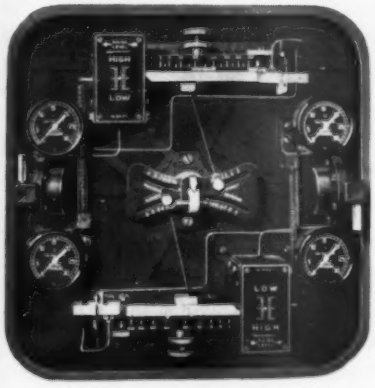
12620 Pneumatic Transmitter



12630 Two-Position Differential-Gap Controller

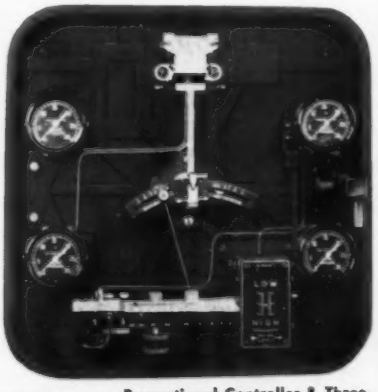


12000-15 Three-Position Pneumatic Signal Switch



12600-00 Duplex Proportional Controller

12610-20 Proportional-Reset Controller & Pneumatic Transmitter



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NIPPONESE NIGHTMARE

(*Concluded from page 426*)

We should, without delay, set up a number of pilot plants to produce certain key equipment or matériel underground. They should be located in remote sections of the country, and should be operated under simulated emergency conditions. They should be operated for periods of time sufficient to shake out all the unknown problems — and to provide the answers.

But that is not all. For every defense measure there must be a countermeasure. It is obvious that we are not alone in planning for future underground production plants. Countries who may be on the opposite side of the fence, come the next war, are making similar studies, are perfecting their plans for subterranean factories which we may want to put out of business some day. It is a sad commentary on human behavior, but, under present conditions we must learn how to destroy as well as how to build. After our pilot plants have served their purpose on the constructive side, they should be turned over to the demolition people, to the bombers, to see how they may be most effectively neutralized. To build and to destroy on such a scale may be a shocking bit of business to the average citizen, and it is. But it may well be the only means, short of the hazards of actual war, to provide answers that we may some day need — desperately.

Certainly such an effort will cost money — plenty. Certainly, the average plant efficiency may be expected to be lower than that of existing surface plants. Certainly, we will have labor problems. Certainly, the difficulties of all kinds will be great. But it is equally certain, that it will cost us more in the long run, possibly our very existence, if we don't know the right answers.

One of the greatest initial difficulties in this matter will be that of developing a proper realization of the urgency of this program on the part of the Congress of the United States. Now broken out all over with a rash of economy, Congress must appropriate the funds necessary for the job. A campaign of public education may be a necessary prerequisite. More than anyone else, the engineer can realize the vital necessity for practical experimentation on such a scale. In matters of this sort, which require disciplined thinking and realistic foresight, the engineering profession can, and must, steer the tides of public opinion in proper directions.

MAIL RETURNS

(*Concluded from page 386*)

"Stepping Stones to Victory" was evidently too late for inclusion in the April issue of the Review, as I feared it might be. Perhaps an early issue might include a statement to the effect that "the opinions or assertions contained in 'Stepping Stones to Victory' are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or of the Naval Services at large."

I am very pleased with the way in which the article was presented. However, I was a little disconcerted that Wake Island appeared to be moved from its old position in latitude 19° 15′ N., longitude 166° 31′ E., to a new location a couple of thousand miles away in the southern hemisphere near Hollandia. The isle we took when the Hollandia strike was made was Wakde.

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ORGANIZATION—A NEGLECTED SCIENCE

(*Continued from page 410*)

voted to manufacturing processes, organization would not be neglected.

It Is Also an Art

You may be asking yourself, however, how an exact science can fulfill the diverse needs of different enterprises. That is a proper question. One of the faults of the case method is that it tends to develop a single, composite design. It proposes to prescribe one medicine for all illnesses, and to clothe every man in the same kind of suit. The science of organization must not fall into that error.

The needs of human enterprise are different. Its purposes cover a wide range. For different purposes, administration must be different. If administration is different, the means of procuring effective administration must also be different. Here, again, we find organization used in two different senses.

As we have been speaking of it, organization is a science of exact principles. But those principles have to be applied to particular cases. This application of the principles is an art. Thus, organization is both a science and an art. As a science, organization should tell us in general how to organize. It should tell us this, just as the principles of mechanics tell us in general how to make machinery; and just as the principles of engineering tell us in general how to build a bridge.

On the other hand, machinery, bridges, and organization have to be used for particular purposes. A machine must be designed for specific service. A bridge must be designed for a specific use. Organization must be designed for the needs of specific administration. In each case, art applies the science. In each case, principles are employed to create a special design. The principles are universal, but they are applied with infinite variation. Though the principles never change, there is undoubtedly one best design for each individual.

The practice of organization depends, therefore, upon mastery of both the science and the art. It demands that the organizer be grounded in the principles. It demands, also, that he have a grasp of the requirements of particular administration, and the ingenuity to apply the principles effectively. Just as the designers of bridges may employ the same principles with greater or less effect, so likewise may organizers.

To emphasize the importance of principle is not to underestimate the importance of skill in application. Practice is as important as principle. But it is no more reasonable to expect to build a bridge by ingenuity alone, than it is to expect to build it by principle alone.

It Is Important

One fact, however, does justify emphasis upon organization as a science. Principle comes before practice. Without principle, there can be no effective practice. On the other hand, there are plenty of ingenious men. Give them principles, and they will do the rest. Give us a science, and the art will take care of itself.

It has been a long time since the individual, unaided by his fellows, has been a significant factor in industrial enterprise. Probably the contribution of individual, inde-

(*Continued on page 432*)

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ORGANIZATION — A NEGLECTED SCIENCE

(*Continued from page 430*)

pendent artisans to the total of industrial production is infinitesimal. It has even come to the point where research in the laboratory — yes, even the thinker in his study — depends for success upon association of effort. The time is past when one man, alone, except in unusual cases, can make any significant contribution to human progress.

Human progress depends upon concert of endeavor. For all that we have, for all that we hope to gain, we depend upon associated effort. Civilization depends upon the endeavor of individuals associated in their respective enterprises.

According as that endeavor is better or worse concerted, its fruits will be greater or less. According as that endeavor is better or worse organized, our enterprises will fare better or worse. Can there be any doubt, then, that the manner of concert or endeavor is of great import? Can there be any doubt that its organization is a problem of the highest concern?

Suppose that, by better organization, one-fifth of industrial intelligence could be released for new pursuits. That is not so extreme a supposition as you might think. There is a current fad that worships committees as an agency of administration in the higher levels. Committees are obviously an employment of several men to do what one man might do. Careless use of them, without regard to their natural aptitudes and failings, can entail a fearful waste of personnel resources. It is amazing how careful an enterprise may be with its money and yet how prodigal of its brains.

But suppose only a tenth of industrial intelligence could be saved. Suppose any proportion you wish. As applied to all of industry, any proportion of saving would be a prodigious fact. Any proportion of saving should offer new horizons of industrial accomplishment.

Suppose, again, that, by better organization, each member of an enterprise could know exactly what his job was. Suppose that he never had to pause and consider whether some particular task was his or another's; suppose there were never a task that he neglected because he did not know it was his. Can anyone fail to realize how that enterprise would forge ahead? As applied to all industry, would not such progress be a prodigious fact?

But the importance of organization does not depend upon proving that enterprises have these defects. It only depends upon realizing that enterprises might have these defects. The bare fact that they might have these defects, and that the cure might achieve such results, is sufficient to confirm the importance of organization as a science.

We can never know whether our concerted endeavors are most effective until we have formulated, accepted, and applied the principles of organization.

It Is Neglected

It is an interesting speculation whether organization is lightly regarded because it has not been thoroughly studied, or whether it has not been thoroughly studied because it is lightly regarded. It is clear enough, however, that it is both lightly regarded and unstudied. A fairly extensive survey shows that probably no more than five or six books have been written that were primarily devoted to organization. It is, of course, much more difficult to survey shorter articles, but these we may dismiss in any event. It is not conceivable that the science of organization could be formulated in a short article. Probably not one of these five or six books masters the science, but that is not the point here. Even if there were five or six books that did, how scant an attention that would be to so important a science!

The *Encyclopaedia Britannica* is a great book. It is a never-failing source of almost inexhaustible knowledge. It will tell you about adding machines, about eschatology, and about zoning. But it will tell you nothing about organization. In the index is "Organization of labour: See Trade unions"; nothing else. There is an article on army organization, but this is only structure; a description of military units and branches. Of organization as a science, the *Encyclopaedia* is unaware.

There are other books, it is true, which make some reference to organization. Generally, these are books on administration. They often fail to identify organization as a separate subject. When they do, it is usually to deal with structure, not with the process by which structures should be created. When they do undertake to deal with principle, it is only as a sidewise glance. It is impossible to accept this as the proper treatment of organization. I do not believe that organization can be the tail on the kite of administration, or that it can fulfill its mission until it has been studied and expounded as a science in its own right.

(*Continued on page 434*)

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ORGANIZATION — A NEGLECTED SCIENCE

(*Continued from page 432*)

For the observation I am about to make, I hope that I may be forgiven. I have no wish to be critical of college curricula. In particular, my remark is not addressed to any one school, and certainly not to the Institute. Such frowardness as may be involved in my remark should be ascribed to my zeal for my subject. I have examined the catalogues of six representative graduate schools of business, hoping to find therein evidences of an appreciation of organization that are lacking elsewhere. These are my findings.

One of the schools has a course in organization, but there is clear evidence in the description of it that it fails to distinguish between organization and administration. Two have courses on "organization and management," in which it is apparent that, although the tail is named first, management, that is, administration, is the kite. In one of these two schools, the course is not given every year. In another two schools there are courses on management which might, upon analysis, show some traces of organization. In the sixth school, no trace can be found. I do not believe that I exaggerate if I say that this is neglect of organization.

If organization is neglected by writers and by schools, it has, of course, no greater attention in industry itself. Perhaps this statement should be qualified. One of our prominent industrial co-operative enterprises says that many businessmen inquire how they ought to organize this or that phase of their endeavors. In this sense, interest in organization is probably more active than it ever was. But, of course, this is not interest in organization as a science. These inquiries only seek to find out what others do, so that they may imitate. They hope to build their bridges, not by application of the principles of engineering, but by copying other bridges. That is no less a neglect of the science because it hopes to enjoy its fruits.

This interest is also belied by acts. One would suppose that, if an enterprise were really interested in organization, it would provide for planning it, the same as it makes provision for its other important concerns. The evidence of such provision is almost wholly lacking. A survey by Holden, Fish, and Smith [3] disclosed that only four of 26 large companies make special provision for the planning of organization. Practically the same result was found by the National Industrial Conference Board [4] — three out of 24.

It Should Be Studied

When we consider the intensive application to most fields of science, and especially when we consider the attention which has been given to such subjects of industrial concern as production, sales, finance, personnel, and indeed, to management or administration itself, we cannot escape the conclusion that the science of organization has been neglected. When we consider, further, the

[3] Holden, Fish, and Smith, *Top-Management Organization and Control* (Stanford University, Calif.: Stanford University Press, 1941), page 45.

[4] Thomas A. Fitzgerald, *Organization Standards and Practices* (New York: National Industrial Conference Board, 1946), page 17.

(*Concluded on page 436*)

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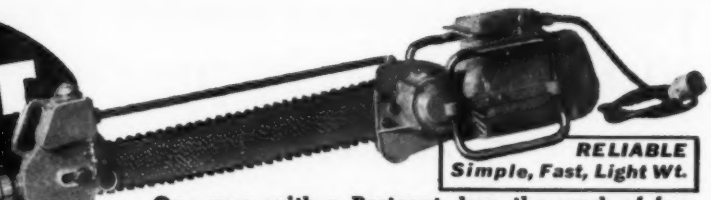

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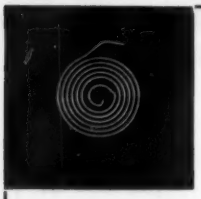
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ORGANIZATION — A NEGLECTED SCIENCE

(*Concluded from page 434*)

great import of organization to our concerted endeavors, we must conclude that this neglect is a sad one.

When I come to this conclusion, I am presented with a dilemma. It is true that I have written a book in which I undertook to formulate the principles of organization. It is true that I wrote the book in full consciousness of the neglect of organization. Apparently, then, I ought to say, either that I have repaired this neglect, or else that the book serves no useful purpose. I do not believe, however, that I have to say either. I have no illusion that one book can make a science. That is a task beyond the capacity of one book or of one man. It is a task that requires many minds. It requires a consensus. I did hope, however, that the writing of the book would help to stimulate interest in the subject, and thus help to begin to end the neglect. If it can make some contribution, however small, to this goal, I shall have all the satisfaction that any man is justified in asking.

Is this neglect of man's endeavors to continue? Shall industry still build its bridges by imitating bridges? Shall we tolerate the notion that what is, is right; and that nothing is to be gained by seeking what ought to be?

This waif of science is on your doorstep. It appeals to your paternal solicitude for all science to give it the shelter which it lacks. Take it in; give it scope; let it grow. Give it place as a science, so that students may be encouraged to study it and to master it. Thus we may hope that man's endeavors will be made more effective by organization.

THE TREND OF AFFAIRS

(*Concluded from page 397*)

These two made an invincible combination. Their mutual respect grew steadily with time. It was Campbell, familiar with the classical current publications of Oliver Heaviside, who worked out the theory of the loaded line as a solution to the vexing problem of distortion. His formulae prescribing how physically to treat the telephone line to correct this defection are standard today. The fact that Dr. Michael I. Pupin won the patents on this achievement detracts in nowise from this independent brilliant achievement under Hayes's inspiration. At the time it was made, the invention of loading gave to the Bell System the means of saving itself from grave embarrassment.

These illustrations give but a glimpse of the contribution of the Hayes Laboratory to the telephone art. By his understanding selection of men and by his regard for scholarly attributes, he gave to the Bell System a scientific and technological heritage of creative minds. Upon his conception of the importance of research and development largely rests that vast establishment of today known as the Bell Telephone Laboratories.

It is characteristic of the electrical industry that its important developments have been of such recent origin that many of the major contributions to this field have occurred in the memory of men still living. Thus, as in the case of Hayes, the growth and progress of an industry are so closely associated with the career of some of its key men that the two are inseparable.

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AMERICAN FOOD PATTERN

(*Concluded from page 404*)

in particular were so enthusiastic about the newly found protective values of leafy green and yellow vegetables and of tomatoes, that they vigorously advocated increased consumption of these foods. This enthusiasm tended to make them ignore the potato, either because they did not recognize its now well-established nutritive values, or because they took it for granted that the consumer would use potatoes liberally. Another element of dietary viewpoint tending to limit potato consumption in certain cases is the entirely fallacious idea that exists in many lay minds of a relationship between potato eating and obesity. With increasingly sedentary existence and a corresponding tendency to overweight, potatoes may often be scorned as fattening, although, in fact, no single food is inherently fattening.

Thus, although potatoes remain a basic staple in the American dietary, the per capita consumption has decreased 25 per cent since 1909. Then the annual consumption of potatoes was close to 200 pounds per capita. Today it is less than 150 pounds.

Will the American food pattern continue to change? Wartime influences are now passing. In time, price and supply relationships will stabilize, shortages should end, and substitutions of unusual foods for the customary but scarce ones should cease. The government's educational program of nutrition (with the theme "U. S. Needs US Strong") which was carried on intensively during World War II has flagged. But conversely the food industries are now bringing up the big guns of specialized promotion of their products, in anticipation of a forthcoming buyers' market in foods. Apparently resumption of the long-term secular trends of the various food groups may be expected, even though points of saturation, or minimum usage, must in time be reached in the instance of foods with rising or falling consumption.

An objective of "High-Level Food Consumption" has been set up by the Bureau of Agricultural Economics of the United States Department of Agriculture. According to the Bureau, high-level food consumption is defined on the basis of two principal considerations. It depends, first of all, on those foods which the nation's people need nutritionally to sustain good health. It depends also, however, on those foods of which our people would like to partake as indicated by food selection and consumption by persons in the higher income brackets. The establishment of universal high-level food consumption in the United States may be expected to improve the health and well-being of the nation's people. But whatever its anticipated efforts, of one thing we may be certain, such a program would require continued change in the American food pattern.

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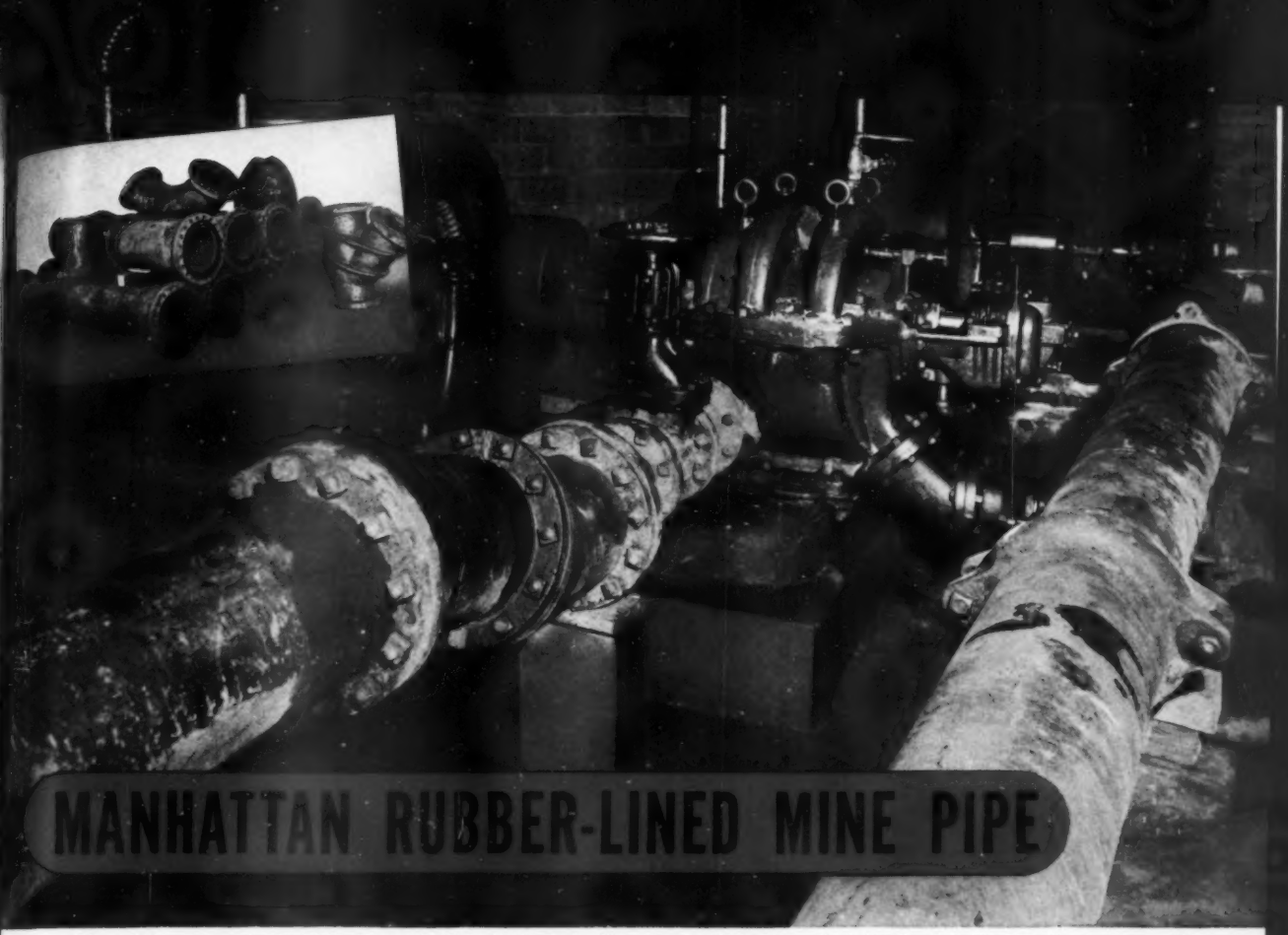

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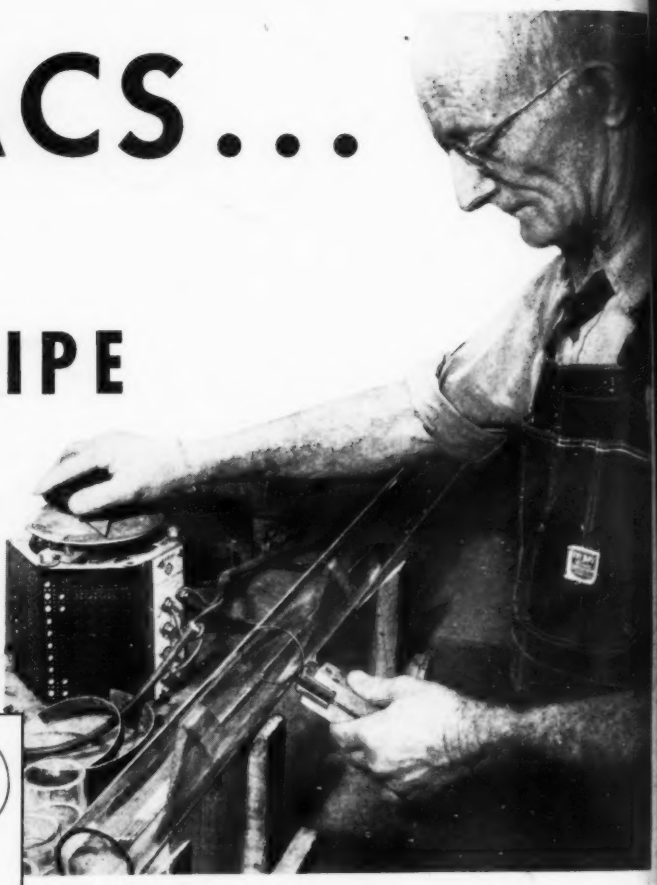

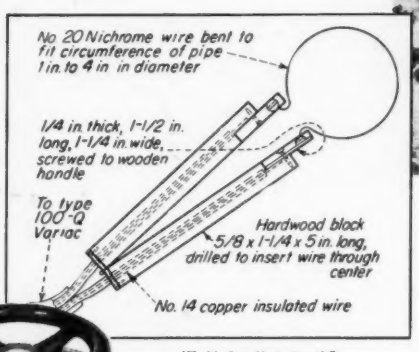
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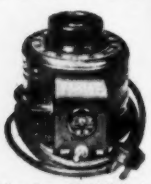

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